

CHEMISTRY

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H: LIQUID HYDROGEN CHILD OF MISSILE AGE

Now Piped for Industrial Use

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Editorial:

Electronic Chemistry Education
Inside Front Cover

50¢

Electronic Chemistry Education

➤ TEACHING BY TV is the hope of harassed school administrators who are plagued by shortages of teachers and money. There are dreams of pouring knowledge into young and not-so-eager brains by means of the electronic screen. The educational application of TV has gone so far, in the case of at least one college, that students do not need to attend classes. They can watch TV from their rooms or student lounges.

There is much to be said for lectures by TV, always presuming that students give as much or more attention to them as they do to teachers actually in the classroom. The lectures can be by the most skillful and persuasive teachers. Once produced and "canned" on film or video tape, they can then be used year after year as often as desired.

Last year's successful telecasting of Atomic Age Physics over NBC's Continental Classroom, a college credit course during the school year primarily for science teachers, was a pioneering venture. Thousands of teachers and others arose with the dawn (6:30 a.m.) to listen to Dr. Harvey E. White of the University of California.

This year, added to a repeat of the atomic lectures, there is a major equivalent chemistry TV course, nation-wide, Modern Chemistry, taught by Dr. John F. Baxter of the University of Florida, and blessed by the American Chemical Society and the American Association of Colleges for Teacher Education. It is designed primarily for high school teachers of science, but other viewing is encouraged.

Dr. Baxter will do many demonstrations with apparatus and chalk and blackboard. It is a lecture-demonstration course, not a laboratory course (p. 13). It will add to the upgrading of science teacher knowledge.

But it is spectator science, nevertheless. To learn chemistry or any other science, the experiments must be done by the student with test tube and chemicals. It is not enough to watch someone else perform with high skill. That is the prize dilemma in TV science teaching.

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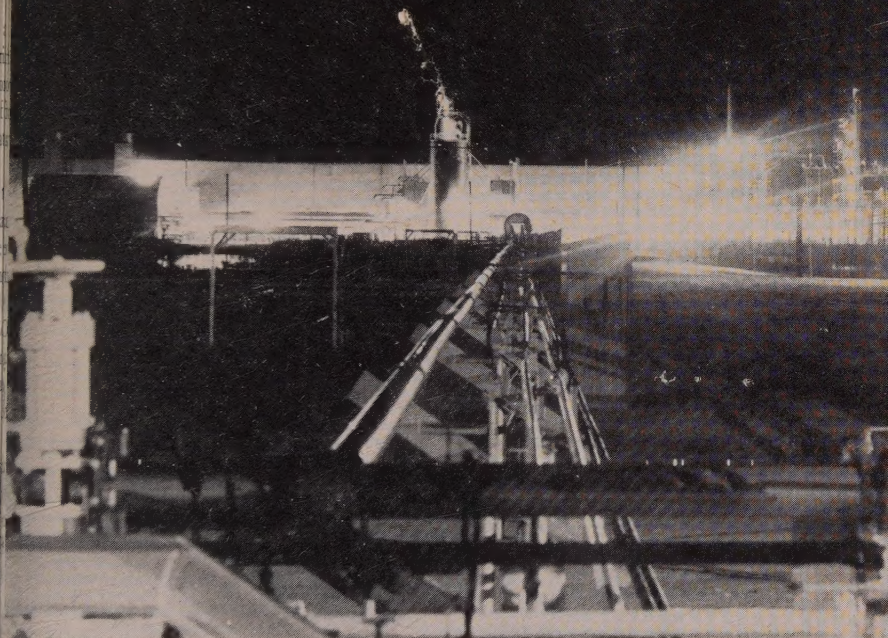
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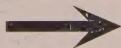
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VACUUM-INSULATED TRANSFER LINES carry liquid hydrogen product long distances from this Air Force Plant No. 74, located near West Palm Beach, Florida. It is anticipated that liquid hydrogen will become a relatively standard utility material, as further methods for handling the chemical are introduced and present methods are improved.

H

Liquid Hydrogen,
Chemical Child
of Missile Age,
Now Piped for
Industrial Use



Liquid Hydrogen

➤ LIQUID HYDROGEN is assuming an increasingly vital role in the nation's defense system. New capability in handling, storing and firing liquid hydrogen in rocket engines substantially improves our nation's lead time in the race for missile and space superiority.

Scientists have long recognized that for energy from chemical combination, no fuel substance equals the energy output of hydrogen. Burned in air or oxygen, hydrogen yields heat of combustion substantially twice that of its next nearest competitor on a weight basis. Beryllium and boron, next in the elemental energy series, provide more energy per pound than gasoline and kerosene, but still only about half that available from hydrogen.

It is well known that a rocket must carry all its own energy as well as its working fluid along right from take-off. Hence, an important objective in selecting a propellant combination is to develop a system with the greatest possible energy content per pound of total missile at takeoff.

For years, scientists and engineers have agreed that liquid hydrogen, boiling at -423°F. , would appear to solve many problems in rocketry. It also appeared that many new problems would need to be solved to develop a mature technology based on this unusual material. As a gas, a liquid, or even a solid, hydrogen is the lightest substance known. As a gas at atmospheric pressure, 200 cubic feet weigh about a pound. The liquid density is only slightly over one-half pound per gallon.

Experience has shown that, despite early warnings to the contrary, liquid hydrogen may be handled very safely. In fact, its safety appears comparable to that of liquid oxygen, which has been handled commercially for many years, with very few accidents.

Chemical Rockets

Specific impulse (I_{sp}) is a primary yardstick of rocket propellant performance. The units are pounds of thrust per pound per second of propellant, usually expressed in seconds.

All such measurements are relative and bear significance only where compared on identical bases. One report based on ignition chamber pressures of 300 psi, operating at sea level, indicates typical relative values. LOX-kerosene mixtures are reported in the range of 260 seconds with LOX-hydrogen at about 350 and $\text{H}_2\text{-F}_2$ combinations about 365. Small differences in I_{sp} are capable of substantially increasing the payload, hence, the strategic importance of developing higher I_{sp} is of the first magnitude.

H_2 -ozone engines at an I_{sp} of about 375 represent the most powerful chemically fueled rocket combination known. For impulse levels beyond this, systems other than chemical reactions must be used to generate energy.

Nuclear Rockets

Currently under test at Jackass Flats, nuclear rockets pose the next breakthrough to space propulsion. In theory, the mechanics are simple. The details are being worked out, but the actual rate of progress is classified.

in a simple form of nuclear rocket, reactor heats up hydrogen gas to exhaust at high velocity into the vacuum of outer space. As the liquid-gas ratio is 850 to 1, the only practical form of portable hydrogen to be used on board a nuclear rocket system is the liquid. Today's estimates of early nuclear rocket systems indicate I_{sp} values about twice the performance of the most powerful chemical rocket propellants.

General Process

The conversion of crude oil into liquid hydrogen is highly complex, but two-thirds of the atoms in a typical crude oil molecule are hydrocarbon atoms, or about one-sixth weight fraction. These oil molecules yield hydrogen directly and, in addition, hydrogen is recovered from water in the form of steam. This portion of the process also eliminates substantial amounts of carbon monoxide impurity and is called a two-stage "steam reforming" reaction. The CO and steam are converted catalytically into CO_2 and hydrogen. CO_2 is then removed by scrubbing with monoethanolamine.

Ortho-Para Conversion

Free hydrogen exists in two different forms — ortho and para. In ortho hydrogen, the two atoms spin in the same direction, while the atoms in the para form spin in opposite directions.

Gaseous hydrogen is largely ortho, however, after liquefaction, the molecule undergoes a slow conversion to para with an energy release which is substantial in comparison with the

heat required to vaporize the liquid. As a result, liquefied ortho hydrogen would entirely vaporize even if stored in a perfectly insulated container. Therefore, it is necessary to conduct a "catalytic" transformation from ortho to para form during cooldown of the gas prior to liquefaction so that the final liquid product is substantially all para hydrogen.

General Properties

Liquid hydrogen is a colorless, odorless material of extremely light weight. It is unsafe to store in an open container . . . its coldness will first liquefy and then immediately freeze the air into crystals of oxygen and nitrogen ice. Solid oxygen crystals in liquid hydrogen are dense and sink to the bottom of the container.

Under such potentially reactive conditions as outlined above, low-order energy input is capable of initiating an explosive reaction. Necessary safety precautions involve anticipation of all such possible contamination. Several years of operating experience with liquid hydrogen without a serious accident speak for the effectiveness of the safety programs employed. It is anticipated that future applications technology will further refine and improve existing methods for handling liquid hydrogen as a relatively standard utility material.

The highly purified hydrogen gas is then deeply refrigerated, subcooled below its liquefaction temperature and stored in specially insulated tankage. The final product is sometimes hauled thousands of miles over the road to distant laboratories.

Answers to CHEMISTRY QUIZ on page 14.

A - 4; B - 4; C - 2; D - 4; E - 1.

Search for Minerals

Show evidence of probable mineral find, often not hard to do, and Government may lend you up to \$250,000.

➤ **BACK-YARD SOURDOUGHS**, who believe valuable mineral deposits may lie within their reach if a little money for exploration were available, can cash in on a program operated by the U. S. Department of the Interior.

Interior's Office of Minerals Exploration (OME) can finance average citizens in search of at least 32 minerals that may lie in your back yard, or in that field just down the block.

Real Exploration

If you can meet the requirements, the Government will lend you up to \$250,000 to do some real exploration work. If you draw a blank, there is no obligation to repay the loan. If you find the prospective mineral, you may share in some profits while paying back your loan on the basis of a five percent royalty.

In two cases, applicants for Federal loans found salable minerals before the Government had put up a single cent. Profits from the first minings paid for the further exploration work. These two applicants wound up by canceling their requests for loans.

New this year, the OME program is a modification and extension of an older program started in the spring of 1951. The earlier program was handled by the Defense Minerals Exploration Administration (DMEA), now replaced by OME. This DMEA program expired last year, but it left behind a set of figures that showed

how handsomely this aid-to-the-small man program had paid off.

Under the old DMEA program, the value of recoverable minerals discovered is estimated to exceed half a billion dollars. This great mineral wealth was uncovered by ordinary citizens at an estimated cost to the Government of about \$30,000,000, including administrative expenses.

A huge deposit of zinc was unearthed in Tennessee. A large lead deposit was discovered in Missouri. A "very large" deposit of fluorspar was found in Illinois. "Pretty sizable" copper deposits were found in several western states. In addition, low-grade iron was found in New Jersey and mercury deposits in Nevada and California.

During its seven years of existence DMEA received 3,888 applications for loans. It signed contracts with 1,155 applicants — about 30% of those who applied — and has paid on these contracts a total of \$22,600,000.

Worthwhile Projects

As of April of this year, 364 projects had been certified, and the value of recoverable minerals from these projects is estimated to top \$500,000,000 at current market prices. Sixty-one projects are still going, and OME anticipates certifying many of these. Forty-two projects had repaid the Government completely, and total repayments to date run more than \$300,000.

"Certification" simply means that the Government believes ore production from the site may be possible one day. Certification usually places a 10-year lien against the property in favor of the Government to guarantee payment of a five percent royalty on the gross proceeds on any production from the property.

How do you go about getting one of the Federal loans? The first step is to do your prospecting. OME Director Frank E. Johnson cautions that OME funds are to be used for exploration, not prospecting.

Prospecting is the search for a mineral deposit. Exploration begins after you have found enough evidence to believe a mineral deposit exists. The purpose of exploration is to determine the extent of the find, and to weigh commercial potentialities.

Technical Advice

If you are an average citizen with no background in geology, you can get excellent technical advice on local mineral deposits from your state's bureau of mines or department of geology. This will not only include information developed by state officials but also data developed by geological teams of the Federal Government. This material might suggest what minerals to look for in your area.

Obtaining the right mineral samples is also important. You may find it profitable to team up with a local geologist or mining expert on a part-time basis. Your partner then could help you find the evidence that OME requires for its loan applications.

Such evidence should include descriptions of known ore reserves in the area, sketches of the geologic features

of the property, and your reasons for expecting to find ore. For instance, your property may have a similar geologic formation to one being mined nearby.

The next step is to get legal access to the property through a lease or an option to buy. If the land is Federal-owned, you must stake a claim in accordance with Federal and state laws. State-owned land in many cases can be leased.

Then you must try to get a loan from two banks, and show in your application to OME either that your request was refused, or why terms of the loans are unacceptable. The banks may, for example, want to make the loan over a 90-day period, much too short a time for mineral exploration in many cases.

After approving your application, the Government will underwrite 50% of the contracted cost but you must supply funds to get the exploration under way for the first month or so. After work has started, you submit a monthly statement of expenditures and OME reimburses you for half of that amount deemed acceptable under contract terms.

Where to Start

If fortunate, you may be able to put your "diggings" on a paying basis early in exploration. For instance, OME's Allen S. Dakan, chief of operations control and statistics, reports that some mica explorations in North Carolina paid off almost from the very start.

You can get full information and application forms from the Office of Minerals Exploration, Department of the Interior, Washington 25, D. C.

New Chemical Patents

To obtain copies of these new patents, order them by number from the Commissioner of Patents, Washington 25, D. C. Enclose 25 cents in coin, money order or Patent Office Coupons (but not stamps) for each patent ordered.

Free Radical Freezer

➤ A METHOD to isolate elusive free radicals in the laboratory has been patented.

Research in the free radical field has far-reaching possibilities. The basic atomic structure of solids can be probed. Much may be learned about the roles free radicals play in electric arcs, inter-stellar dust, galaxies, and comets.

Working at the National Bureau of Standards, two scientists duplicated in the laboratory what occurs in the vast interstellar dust — they froze and isolated free radicals.

Drs. Herbert P. Broida of Bethesda, Md., and John R. Pellam of Pasadena, Calif., made gases flow through a high-frequency electric discharge. This discharge separated the free radicals from their molecules. The very excited free radicals were then quickly pumped, by means of a vacuum effect, to a surface cooled by liquid helium to a few degrees above absolute zero (minus 459.7 degrees Fahrenheit). On this frigid surface the radicals immediately froze into solid form and remained isolated for many hours.

When Drs. Broida and Pellam sent nitrogen through their apparatus a most spectacular effect was produced. A brilliant green glow was emitted from the frigid surface. By spectroscopic analysis the researchers showed that the green glow was produced by

isolated, excited nitrogen atoms. (Nitrogen usually is found in molecules consisting of two nitrogen atoms.)

Since the invention of the free radical freezer four years ago, extensive work has been done at the Bureau of Standards involving a "large variety of materials and temperatures," Dr. Broida told Science Service.

Drs. Broida and Pellam were awarded patent No. 2,892,766 and signed the patent to the U. S. Department of Commerce.

Portable Radioactive Source

➤ A PORTABLE X-RAY UNIT has been invented for use in the field by U. S. Army doctors. The field unit, which employs a radioactive source, requires no electricity for its operation.

The portable radioactive source won for its co-inventors, Raymond Goertz and Lenard M. Safranski of Downers Grove, Kenneth R. Ferguson of Lisle, and Elmer W. Ryland of Lemont, Ill., patent No. 2,891,167.

The inventors state their device is light enough to be portable and that the radioactive source can be easily replaced. To facilitate replacement the active core is mounted in a tungsten rotor that can be turned 180 degrees. At one position the radioactive material is completely shielded and at the opposite position the core is completely exposed.

The patent was assigned to the U. S. Atomic Energy Commission.

Machine Tests Plastics

TO TEST the strength of plastics and their rigidity under heat, weights are dropped on specimens in an invention by Wyman Goss and Eliot R. Andrews of Pittsfield, Mass.

To find the impact strength of a plastic, a disc-shaped sample is mounted on a rim. From above the rim, carefully measured weights are dropped from known distances. When the plastic cracks, the impact strength of the plastic in foot pounds can be easily calculated by multiplying the weight of the weight times the weight in pounds.

'Hot rigidity,' the firmness of plastics at high temperatures, is an important factor in many methods of molding plastics. To test 'hot rigidity' the plastic disc is mounted directly above a shaft that operates a chronometer. As the plastic is slowly heated, weights are lowered onto the sample at regular time intervals. When the plastic loses its rigidity and becomes slightly deformed, the deflection is immediately registered on the micrometer.

The invention was granted patent No. 2,892,342, and assigned to General Electric Company.

Fluorocarbons Obtained

WIDER USAGE of fluorocarbon compounds may result from an economical method of preparing them invented by Mark W. Farlow of Wilmington, Del. Fluorocarbons are used as refrigerants, dielectric fluids, propellants in aerosol compositions, and polymers.

A compound containing fluorocarbons is heated to a temperature of

1500 degrees in either an induction-heated graphite tube furnace or a carbon arc. At this high temperature the compound vaporizes. The vapor is then passed through a tower containing sodium fluoride pellets to remove any hydrogen fluoride formed in the reaction, since only carbon-fluoride compounds are desired. A liquid nitrogen trap cools the vapor and a number of fluorocarbons are produced. A fractionating column further separates the fluorocarbon compounds.

The patent, No. 2,894,996, was assigned to E. I. du Pont de Nemours and Company.

Oxidizer Extracts Uranium

► A NEW METHOD of extracting uranium from uranium ores using manganese dioxide as part of a percolating or leaching agent won Eugene J. Michal of Corpus Christi, Texas, and Robert R. Porter of Northcliff, Johannesburg, Transvaal, Union of South Africa, patent No. 2,890,933.

To extract the uranium, a solution of manganese dioxide and iron salts in sulfuric acid is percolated through the ore. The solution oxidizes the uranium and thus separates the uranium from its ore. The manganese dioxide is particularly effective as an oxidizer. The inventors report the process requires no extra heat and that it can extract uranium when it comprises only a few thousandths of a percent of the raw material. They cited an example in which they were able to extract 97.4% of the uranium present in uranium bearing sandstone ore containing some shale from the Hite area of Utah. The invention was assigned to the U. S. Atomic Energy Commission.

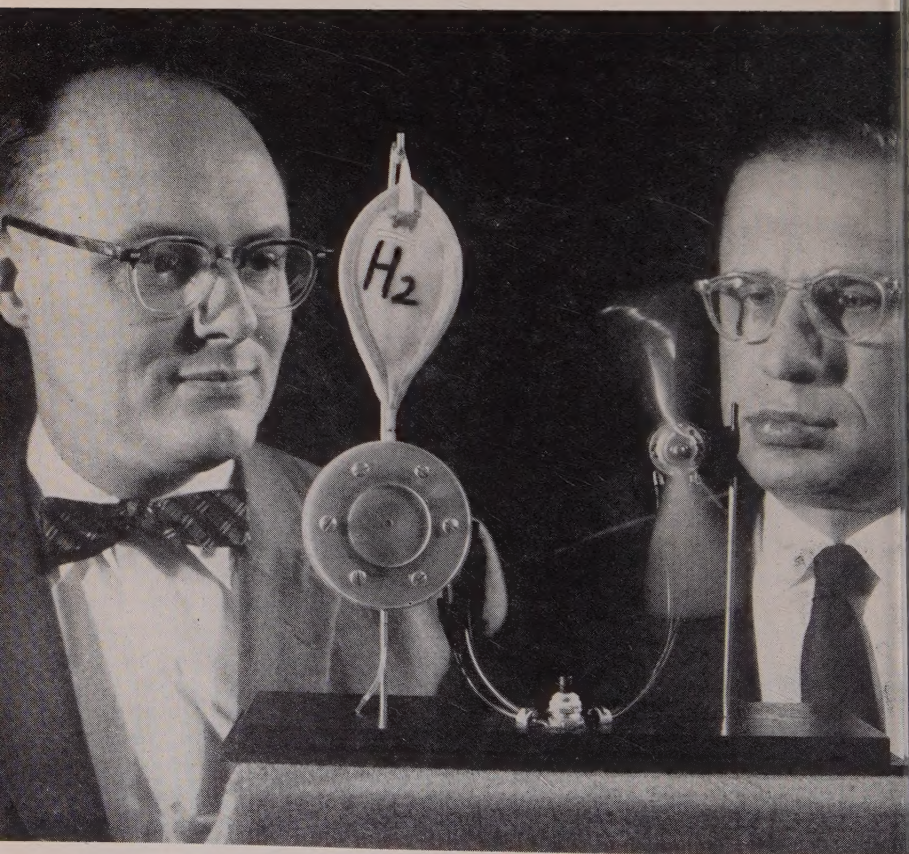
Fuel Cell Improved

➤ AN IMPROVED fuel cell that produces electricity directly from oxygen and hydrogen has been developed.

The fuel cell generates electricity by means of a chemical reaction. In

this cell, described by General Electric scientists, hydrogen and oxygen produce the electric current, giving water as a by-product.

The new device operates efficiently



➤ THIS FUEL CELL, producing electricity directly from gaseous fuel, is demonstrated by General Electric Research Laboratory scientists. Dr. Leonard W. Niedrach (left) and Dr. W. Thomas Grubb, who are responsible for the device, look on as the electricity generated in the small plastic cell spins miniature propeller.

room temperature and normal atmospheric pressure. Thermal efficiencies over 60% have been obtained.

"We cannot yet determine how competitive it will be with other power sources," he said, "but its special characteristics may well fit it for a variety of uses. . . Military and space vehicle applications might make use of the fuel cell's high reliability, simplicity, portability, light weight, and small volume."

The fuel cell consists of a round plastic disk about one-half inch thick and three inches in diameter. Its hollow interior is divided into two chambers by a special plastic membrane, which has an electrode in contact with each of its sides. Hydrogen is fed into one chamber, and oxygen into the other (or oxygen in the air can be used). At one electrode, the hydrogen molecules break up into electrons and positively charged hydrogen. The electrons travel through an external circuit to the other electrode, thus generating an electric current. The positively charged hydrogen moves through the membrane to the other electrode, where it combines with oxygen and the electrons from the external circuit to form water.

The broad principles of this device are common to all fuel cells, but the one described above is novel in employing an ion exchange membrane as an electrolyte. This has an advantage over aqueous electrolytes, in that electrolytically conducting ions are "locked in", and cannot be leached from the cell. These membranes also reject water when they reach saturation, and, therefore, no difficulty is experienced from dilution effects. These features combine to simplify

the operation of the cell, because they provide built-in controls for maintaining the electrolyte concentration and the water balance.

In addition, the electrolyte may be *acidic*, consisting of a cation exchange resin in its hydrogen form. The use of an acidic electrolyte makes it possible to use gases containing carbon dioxide, e.g., air.

In cells using caustic electrolytes, such as potassium hydroxide, the hydroxyl ion is the charge carrier, and the water produced by the net cell reaction forms at the fuel electrode. Here, the hydrogen ion is the charge carrier, and the water forms at the oxidant electrode. This is advantageous when the cell is operated on air, since the water can be disposed of by controlled evaporation.

Among the other features that should be noted are the following: the solid polymer electrolyte makes possible very compact cell structure, operation on static heads of gas is possible, no moving parts are involved, and close tolerances are not involved in the construction of the cell.

A number of cells have been operating continuously for from 75 to 100 days, and these tests have not yet been concluded. One cell has operated for more than 100 days, and is still running. Two cells have been operated with their cathodes exposed to the air; one of them is still running after more than 75 days. Portions of these tests have been conducted at current densities of 30 ma/cm², although most of the operation has been at lower current densities.

The cells have been operated mainly on commercially available hydrogen and oxygen.

Serving the Paint Industry

➤ MORE THAN half a century ago, manufacturers in the paint industry realized that in order to protect their interests, promote the sale of their products, insure a high standard of manufacturing practices, and provide the best quality paint, varnish, and lacquer to the buying public, it would be of great benefit to them and to their consumers if they united into a nationwide association.

In the Grand Union Hotel, Saratoga, New York, on September 11, 1888, the paint clubs then in existence met to agree upon an organization plan and the name for a national association. These groups included: The Paint and Oil Club of New England (1884), a presently thriving organization now known as the New England Paint, Varnish and Lacquer Association; the St. Louis Paint, Varnish and Lacquer Association (1886); Chicago, New York, Philadelphia and Pittsburgh (all formed in 1887); and Cincinnati (1888).

Other regional organizations followed by organizing such groups as the Paint Grinders' Association of the U. S. (1889), which was to become the Paint Manufacturers' Association of the U. S. in 1907; and the National Varnish Manufacturers' Association (1903). In 1926 these two associations combined to form the American Paint and Varnish Manufacturers' Association.

At the Annual Meeting of the industry held in Chicago in 1933, the National Paint, Varnish and Lacquer

Association was officially named and recognized. The NPVLA was a consolidation of the American Paint and Varnish Manufacturers' Association and the National Paint, Oil and Varnish Association. Membership was open to manufacturers of finished paint and allied products; manufacturers of raw materials, containers, and equipment used by the industry; manufacturers' agents, importers, trade publication representatives and others who rendered service of value to the industry and who were members of local affiliated associations; Canadian manufacturers, and wholesale distributors.

The purpose of the Association is to promote the welfare of the industry, to strengthen business and fraternal relations among its members, to remove evils and customs contrary to sound business principles and ethics, and to safeguard the interests of the public. All members must subscribe to the Association's Code of Ethics and sign its agreements relating to non-exchange of products and anti-bribery.

The Association is divided into two principal divisions — the Chemical Coatings Division and the Trade Sales Division. Chemical Coatings promotes the general welfare of manufacturers of products used in factory finishing, through its constant activity with members concerning policy, practice, and products. Close cooperation is maintained with furniture and metal fabricators, and other product

manufacturers to broaden the coats market and keep abreast of end-users requirements. Sales training and promotional programs and seminar discussions are developed to benefit members, and regular technical and business meetings are held. This division also works toward developing new markets through other industries which need finishes to decorate and protect their products and to make them serviceable, sanitary, and immediately saleable.

The Trade Sales Division promotes selective selling for the manufacturers products sold through dealers to the consumer, and its work is closely coordinated with other divisions of the National Association and local associations. Time payment plans, cooperation with painters in the development of new markets, and development of consumer confidence in the products are the types of work carried out by this division. The Putty, Filling and Caulking Compounds and Roof Coatings Divisions are also administered as an allied part of Trade Sales.

The Association's clearing house requests and information relating to the technical aspects of the industry, is the Technical Division which oversees and administers scientific and technical programs. It also plays a leading role in the development of educational programs. This division coordinates, through its Scientific Section, research projects, technical investigations and dissemination of technical data.

The Scientific Section keeps members informed of new developments and changes in the allied fields of chemistry, physics, engineering, and

biology. Its laboratory is equipped to conduct specially designed scientific inquiries and to supplement information provided by Governmental and private groups. The Technical Publication Branch of this Section collects and distributes technical data of interest to industry members through its Raw Material Indexes, Guide to U. S. Government Paint Specifications, Abstract Reviews, Technical Bulletins, and the like.

The Legal Affairs and Legislative and Liaison Divisions are the industry's representatives in Washington, and watch all Federal, state, and municipal legislation on regulations pertaining to the industry. By long and close cooperation with state and Federal agencies, a prestige has been achieved which provides a friendly and cooperative attitude.

Other sections within the Legal Division include the Traffic Bureau which endeavors to improve and protect the position of the industry, and has been successful in bringing about adjustments which have saved the industry millions of dollars during past years; the Trademark Bureau lists more than 35,000 trade marks, names, and brands, and furnishes prompt information to any member of the Association who is considering a new trademark or brand name. It has saved thousands of dollars for members in avoiding the expense of litigation. Unfair competition, unfair trade practices, misbranding, mislabeling, false advertising, and other trade abuses are all within the operations of the Legal Division.

The Statistical and Liaison Division provides information and data to members which assists them in con-

ducting marketing and economic research programs. Close personal contact with many Governmental agencies such as Census, Labor, FHA, and Defense, provides up-to-the-minute data, changes, and policy proposals that are of interest to the industry. Statistical information is disseminated to members through periodic reports, an Annual Color Survey, the Statistical Handbook, and other publications.

The Public Information Division assists in developing the industry's markets through a continuous high-keyed program of promotion and publicity, utilizing every medium of advertising and promotion. This division also supervises publication and distribution of books, "how-to" pamphlets, films and the weekly news letter "Coatings." It acts as liaison with the Association's public relations and publicity counsel, and is responsible for the development and promotion of the "Hidden Power" sales training program.

Other promotional and publicity activities have been expanded under the guidance of the Association's public relations counsel, Ted Deglin & Associates, Inc., of New York. Material designed to educate the consumer public and to stimulate sales has appeared in the important shelter magazines and on radio and television shows.

The Clean-Up Paint-Up Fix-Up Bureau is a public service function performed under Association supervision. Working through hundreds of local civic and governmental groups, the Bureau annually sponsors Clean-Up, Paint-Up, Fix-Up campaigns which plan and promote the way to

better health, safety, improved living conditions, and the stimulation of civic pride.

In addition to these Divisions, the Association has approximately 50 other committees and sub-committees who carry on the work of the Association, promoting its aims and objectives, and providing a wide scope of service to the industry and to the public.

The vast and far-reaching influence of the paint, varnish, and lacquer industry exerts a tremendous impact upon our daily living. Today there are more than 1,500 paint, varnish and lacquer manufacturers in the United States. These companies employ more than 77,000 people. Salesmen, dealers, professional painters, decorators, and many others increase the number of industry representatives to well over half a million.

The future of the industry shows great promise in the fields of research and in the development of new products. Because of the general increase of our population and its predicted rise, the American market will soon be called upon to mass produce billions of dollars worth of merchandise — practically all of which will require a protective coating or a colorful finish.

Today, more than ever before, science and the paint industry go hand in hand. Guided missiles and rockets must have protective, high-temperature and friction resistant finishes that will allow them to probe the great infinity of outer space in safety. Vast projects that will be undertaken in the scientific program of space ex-

ration will require coatings and
nt products for the successful com-
tion of their objectives.

Thus the expansion of the industry
of the continuing activity of the Na-
tional Association, will be inevitable
supply the tremendous demand the

public will have for its products. The
next decade will see a great surge
ahead as paint industry technicians
continue their never-ending search to
create more and better products for
the beautification and protection of
the world.



CONTINENTAL CLASSROOM — Dr. John F. Baxter of the University of Florida, demonstrates the molecular structure of octane, an important paraffin hydrocarbon. Dr. Baxter has filmed 160 demonstration lectures which will be telecast beginning this fall on Continental Classroom (NBC) at 6:30 a.m.

✓ Chemistry Quiz ✓

Directions: Mark the answer you think most nearly correct.

Answers are on page 3.

- | | | | | | | | | | | | | | | | | | | | | | |
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| <p>A. The scientist who first proposed the Quantum Theory was</p> <table border="0" style="width: 100%;"> <tr> <td>1. Bohr</td> <td>3. Einstein</td> </tr> <tr> <td>2. Dalton</td> <td>4. Planck</td> </tr> </table> <p>B. A <i>sudorific</i> is an agent used to induce</p> <table border="0" style="width: 100%;"> <tr> <td>1. esterification</td> <td>3. sleep</td> </tr> <tr> <td>2. hallucinations</td> <td>4. sweating</td> </tr> </table> <p>C. If a 1 normal solution of HCl contains 1.0081 grams of hydrogen ions per liter, what is the pH of a 0.01 normal solution of HCl?</p> <table border="0" style="width: 100%;"> <tr> <td>1. 1</td> <td>3. -1</td> </tr> <tr> <td>2. 2</td> <td>4. -2</td> </tr> </table> | 1. Bohr | 3. Einstein | 2. Dalton | 4. Planck | 1. esterification | 3. sleep | 2. hallucinations | 4. sweating | 1. 1 | 3. -1 | 2. 2 | 4. -2 | <p>D. The periodic table of the elements was first arranged and used by</p> <table border="0" style="width: 100%;"> <tr> <td>1. Einstein</td> <td>3. Lavoisier</td> </tr> <tr> <td>2. Kelvin</td> <td>4. Mendeleev</td> </tr> </table> <p>E. Which of the following is most closely related to <i>entropy</i>?</p> <table border="0" style="width: 100%;"> <tr> <td>1. calorie</td> <td>3. gear train</td> </tr> <tr> <td>2. enzyme</td> <td>4. gene</td> </tr> </table> <p><i>Complete copies (with answers and norms) of many previous Science Talent Search examinations are available at 10c each from Science Service, 1719 N St., N.W., Washington D. C.</i></p> | 1. Einstein | 3. Lavoisier | 2. Kelvin | 4. Mendeleev | 1. calorie | 3. gear train | 2. enzyme | 4. gene |
| 1. Bohr | 3. Einstein | | | | | | | | | | | | | | | | | | | | |
| 2. Dalton | 4. Planck | | | | | | | | | | | | | | | | | | | | |
| 1. esterification | 3. sleep | | | | | | | | | | | | | | | | | | | | |
| 2. hallucinations | 4. sweating | | | | | | | | | | | | | | | | | | | | |
| 1. 1 | 3. -1 | | | | | | | | | | | | | | | | | | | | |
| 2. 2 | 4. -2 | | | | | | | | | | | | | | | | | | | | |
| 1. Einstein | 3. Lavoisier | | | | | | | | | | | | | | | | | | | | |
| 2. Kelvin | 4. Mendeleev | | | | | | | | | | | | | | | | | | | | |
| 1. calorie | 3. gear train | | | | | | | | | | | | | | | | | | | | |
| 2. enzyme | 4. gene | | | | | | | | | | | | | | | | | | | | |

National Science Youth Month

➤ OCTOBER will be National Science Youth Month this year. National organizations will cooperate in a month-long action program to inspire and inform youth in our schools about career opportunities and qualifications in science and technology.

Millions of students in the public, private, and parochial secondary schools of the nation provide the nucleus of this emphasis on science activities of the new school year. Organization of science clubs and science fairs in all parts of the country will be stressed.

A booklet of suggested activities and relevant information has been prepared for those in local and regional organizations who wish to cooperate. The booklet and other ma-

terial for nationwide distribution have been produced by Science Service as part of its National Science Youth Program supported in part by the National Science Foundation.

Thirty-four national organizations are cooperating in National Science Youth Month, with Science Service as the coordinating agency. This is the fourth year that October has been National Science Youth Month.

Greatly increased interest in discovering and stimulating youthful ability in science and technology is reflected in new or expanded science youth programs set up by national organizations. Six additional agencies are cooperating in National Science Youth Month in 1959.

Antithetic Oxides of Carbon

by BURTON L. HAWK

I. CARBON MONOXIDE

WE HAVE LEARNED a new word this month, which is used in the title. If you don't know what it means, be sure to look it up in the dictionary.

Perhaps you have heard proud parts proclaim:

"Johnny is *so* different from Billy. You would never realize they were brothers!"

This example can be considered an analogy for the oxides of carbon. Although from the same "family," they have quite different personalities. Both are colorless, odorless gases, but their similarity ends.

One is essential to life, the other is a deadly poison. One is an efficient fuel, the other is a popular fire extinguisher. One is lighter than air, the other is heavier. One is solidified quite easily and is used as a refrigerant, the other is very difficult to liquefy. One dissolves in water quite easily and the resultant solution forms the basis of many popular beverages, the other is only very sparingly soluble in water.

Poisonous Properties

This time we will consider the unpopular member of the family: carbon monoxide. The poisonous properties of this compound have been widely publicized. The gas, when inhaled, combines readily with the hemoglobin of the blood. Ordinarily, oxygen combines with the hemoglobin to form an unstable compound. This compound transports the oxygen from the lungs to various parts of the

body. The monoxide combines with the hemoglobin much more readily than the oxygen. Hence, when this gas is inhaled the blood cannot transport oxygen to where it is needed and death results.

While we do not recommend this experiment for the beginner, there should be no real danger if proper precaution is taken. Remember carbon monoxide is extremely treacherous in that its presence cannot be detected. Proper ventilation must be maintained and only very small quantities should be prepared at one time.

Preparation

In the laboratory, carbon monoxide is best prepared by the dehydration of formic acid and collected by the displacement of water. In an Erlenmeyer flask, place 5 cc. of concentrated sulfuric acid, then insert a stopper containing a thistle tube and outlet tube leading to a gas bottle inverted over water. Be sure the bottom of the thistle tube is immersed in the acid. Now cautiously add 1 cc. of formic acid through the thistle tube. Make sure the outlet tubing is inserted in the gas bottle, then apply *gentle* heat to the flask. Do not heat too strongly as the action may become more vigorous than desired. The gas will bubble through the hose and displace the water in the inverted receiving bottle. Collect several small bottles of the gas in this manner. The first bottle may be discarded as it is a mixture of the air present in the

flask along with some carbon monoxide. The other bottles, however, should be pure carbon monoxide.

When all the gas you desire has been collected, disconnect the tubing *first*, then discontinue heating. This is done to prevent any water being sucked back into the flask. Remove the stopper from the flask and quickly pour the contents down the drain and flood with large quantities of water. Never pour cold water on top of the hot acid! By disposing of the contents in the flask quickly, a minimum amount of carbon monoxide will be released. In any event, make sure there is plenty of ventilation.

Tests for the Gas

Remove the second bottle of gas collected from the pan of water by holding a plate of glass tight against the mouth of the bottle, removing quickly from the water, and setting upright on your lab table. Remove the glass plate and quickly hold a lighted match (held with a tongs) over the mouth of the bottle. The gas burns quickly with a blue flame. Remove another bottle of gas from the water. Remove the gas plate and very quickly pour in a little lime water. Replace the glass cover rapidly to prevent the escape of the carbon monoxide. Holding the cover, shake the bottle. Note there is no change in the lime water. Now, ignite the gas as described above.

As soon as the flame disappears, replace the cover and again shake the bottle. This time the lime water should appear cloudy indicating the presence of carbon dioxide and further indicating that this compound is obtained from the combustion of carbon monoxide.

Reducing Agent

Carbon monoxide is an effective reducing agent and this fact can be demonstrated by the following experiment. Here again the gas is generated in an Erlenmeyer flask by adding formic acid, in very small quantities to about 5 cc. of concentrated sulfuric acid. Allow the outlet tube to lead to a horizontal tube, which should be of Pyrex, containing a small quantity of cupric oxide. (You can make the tube by carefully breaking off the bottom of a test tube, but be sure to fire-polish the broken end. This is done by placing the end of the tube in the hottest part of the burner and heating it until the sharp edges melt and become rounded. The tube must be rotated so that the fire-polishing will be smooth and even.)

The outlet at the other end of the horizontal tube is connected to a rubber tubing which extends to an open window. Thus any released gas will not be available for unwary inhalation. Apply heat to both the flask and the tube. Allow the carbon monoxide to pass over the heated cupric oxide for a short while. Then disconnect the apparatus and dispose of the contents in the flask quickly as outlined in the previous experiment. Examine the cupric oxide. Note that it has been reduced to cuprous oxide (reddish brown powder) or to the metal depending on how long you have carried out the reaction.

Carbon monoxide is most important as a fuel, usually in such mixtures as watergas, producer gas, and blast-furnace gas. It is also an important reducing agent in the metallurgical industries, particularly for iron, copper, and zinc.

Scientists Revise Chemical Names

AN INTERNATIONAL group of scientists is revising and determining the rules for names and symbols of inorganic chemicals throughout the world.

Dr. Alexander Silverman, professor emeritus of chemistry in the Division of the Natural Sciences of the University of Pittsburgh, has been president of the organization, known as the Commission on Inorganic Nomenclature of the International Union of Pure and Applied Chemistry, since 1955 and its only American representative.

The Commission meets regularly in cities throughout the world to provide and vote the official world rules for naming inorganic chemicals to satisfy both history and the just wishes of the discovering nations. The Commission has the authority to name the inorganic chemical elements that have been discovered and that will be discovered from time to time. Their findings are used all over the world.

The ten-man group, which during Dr. Silverman's four years of presidency has had 100% attendance, is composed for the most part of professors of inorganic chemistry in leading universities of the world. The present group consists of scientists from Denmark, Holland, England and Tasmania, France, Switzerland, Italy, Sweden, and Germany. In addition from time to time delegates are called from every country of the world in an advisory capacity.

The results of their last meeting in Paris in 1957 have just been published as a book in England and will prob-

ably appear soon in this country in the Journal of the American Chemical Society. The book is printed in both English and French on facing pages. The names vary only according to language differences; the symbols, an international language in themselves, are always the same.

The work of revising the first 1940 edition that took final shape in Paris, 1957 has continued into the finest detail for two years, going from the vote of the July Commission meeting to a five-man subcommittee headed by University of Copenhagen professor H. A. Jensen, a leading authority on the history of the chemical elements. From the subcommittee the decisions went to the International Union of Pure and Applied Chemistry for approval, and finally to the publisher, Butterworths Scientific Publications, in London.

Many problems arise in the vast project of judging and naming chemicals. Rules may relax because of common usage, as in the case of *Wolfram*, known generally in America, England, and France as *Tungsten*. After discussion it was determined that the name *Tungsten* be permitted to stand in those countries, but its symbol is *W*, for *Wolfram*.

Language difference also create problems, as in the case of the symbol for *Mendelevium*, which was changed from *Mv* to *Md* because so many alphabets have no *v*. Duplications must be watched, so that the symbol *E*, for example, for *Einsteinium*, was altered to *Es*, since *E* is also the symbol for energy.

Synthesis of Some Organic Acids

by CHARLES D. SCUDDER, III, J. M. Atherton H. S., Louisville, Ky.

Given Honors in the 18th Science Talent Search

➤ ORGANIC ACIDS play an important role in our complex world of today. They are used in the manufacture of many useful products such as paints, dyes, soaps and insecticides.

It was the purpose of this project to devise a method by which a large number of homologous organic acids could easily be prepared. Such a synthesis was developed and two acids, formic and acetic, were prepared. An unsuccessful attempt to produce trimethyl acetic acid necessitated a possible explanation of the failure and suggestions as to how the difficulty could be overcome.

Major Problems

At the outset of any synthesis many factors must be considered. For example, the starting products must be readily obtainable or easily made. No harmful by-products or dangerous compounds should be produced by uncontrolled side reactions. All reactions should be easily run to completion; and, they should be as nearly

Charles Scudder was accorded honors in the 18th Annual Science Talent Search for the Westinghouse scholarships and awards. He is hoping to study chemistry at Princeton and plans to go into medicine or chemistry.

Information about the Science Talent Search may be obtained from Science Service, 1719 N St., N.W., Washington 6, D. C.

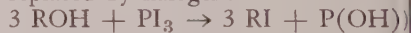
quantitative as possible to secure practical yield with respect to the amount of starting products.

The alcohols were chosen as starting products because of their ease of preparation and the relative reactivity of the hydroxyl group they contain. A modification of the Grignard synthesis was used to introduce the carboxyl group into the required compounds. Finally, the acid distillation method was used to purify the product.

Theory and Equations

Alkyl Halides:

If an alcohol is heated with a halide of phosphorous, the hydroxyl group is replaced by halogen:



Grignard Synthesis:

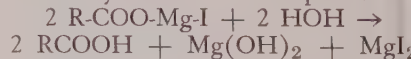
If an alkyl halide is heated with magnesium, an organometallic compound is formed:



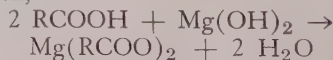
On treating with carbon dioxide,



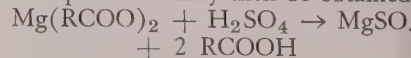
Water hydrolyzes this compound:



Then,



The pure acid may then be obtained



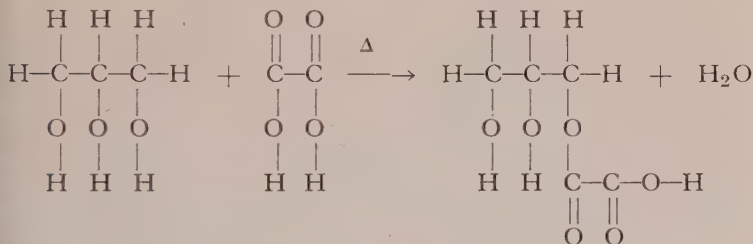
and recovered by distillation.

Actual Experiments

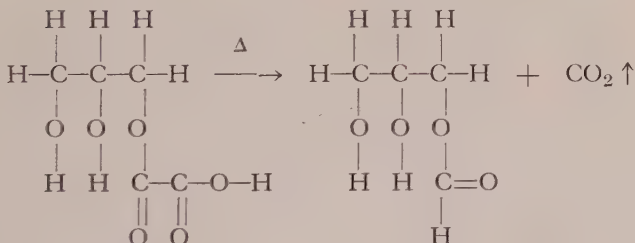
Since formic acid is the first member in the homologous series of the aliphatic saturated monobasic acids and does not contain a complete

methyl group, a different method was resorted to to produce it.

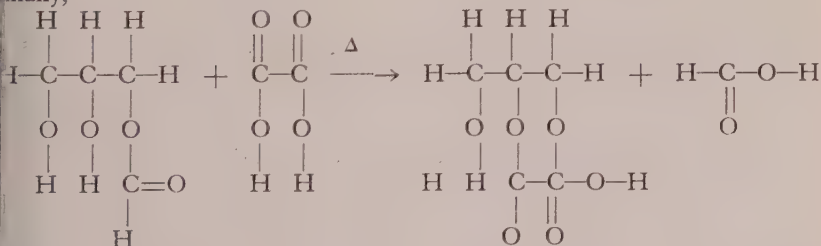
When glycerin and oxalic acid are heated together, a series of complex reactions takes place ending with the production of formic acid:



then,



finally,



The resulting formic acid was separated by fractional distillation.

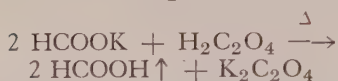
Purification

Since the removal of water from formic acid is not possible by fractional distillation (boiling point of water = 100.0°C.; boiling point of formic acid = 100.5°C.), it was nec-

essary to resort to a more difficult method. The method chosen was to convert the liquid into a solid compound, drying this compound, and then reconvertng it into the acid.

First, the acid was placed in a flask and potassium hydroxide along with phenolphthalein was added. When

the mixture turned red, it was slowly evaporated and the resulting mass of crystals fused.



The potassium salt was chosen because of its high melting point (150+ C.). When fused, all water was driven off. Gentle heat only was used to prevent decomposition of the potassium formate. Oxalic acid was added to the dry salt; the temperature was raised to 110°C. Nearly pure formic acid distilled over and is available for inspection on request.

Acetic Acid

Acetic acid, containing an intact methyl group, lends itself to the general procedure outlined at the beginning of this report.

Methyl alcohol was placed in a flask connected to a reflux condenser. Ten grams of red phosphorous and 70 grams of iodine crystals were carefully added. The mixture was refluxed for six hours and then distilled, the fraction boiling at 30-45 C. being collected. The distillate was received in a vessel cooled by a salt-ice mixture. Approximately 25 mls. of methyl iodide were produced (for equations, see Theory and Equations).

This liquid was dried twice for 24 hours with 50 grams of anhydrous calcium chloride. It was noted that a slight decomposition resulted as the methyl iodide aged and turned brown. Several copper turnings were added to absorb free iodine. Careful distillation yielded about 18 cc. of pure, dry methyl iodide.

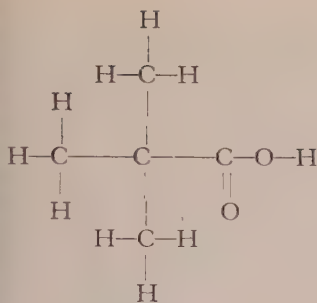
Ether (previously dried by treatment with sodium and distillation over a water bath) and the methyl iodide were mixed and placed in a dry bottle containing a one-hole stopper and a glass tube extending to the bottom of the bottle. Several strips of magnesium and a crystal of iodine were added and the bottle placed in warm water. A vigorous reaction which lasted for several minutes resulted. Immediately carbon dioxide from a prepared generator was passed through the tube in the bottle and bubbled through the solution. This process was continued for several hours. The liquid in the bottle was then transferred to a test tube and evaporated to dryness. A mass of fine white crystals remained. These were dissolved in 25 mls. of distilled water.

Thirty mls. of concentrated sulfuric acid were added to the solution and the mixture carefully distilled. The fraction boiling below 200 C. was collected. Some iodine and hydriodic acid distilled over into the acid. Copper turnings were again added and the mixture redistilled. The acid was estimated to be about 30%, and could have been purified as described under formic acid. However, due to lack of time, the acid was not purified.

Because of the lack of time, the synthesis of the two propionic acids was postponed and work begun on a higher and more complex acid, one derived from butyl alcohol.*

Tertiary butyl alcohol was used as a starting product so that the valeric acid isomer having the formula

* This acid could not be located in the literature (see appendix) and (as far as the author knows) has never been prepared by the above method.



could be prepared.

About 100 mls. of tertiary butyl alcohol were added to a flask connected with a reflux condenser. Ten grams of red phosphorus and 70 grams of iodine were added and the material refluxed for six hours. The mixture was then distilled and the fraction boiling at 60-80 C. was collected. Quite by accident it was discovered that the distillate was highly inflammable. This fact meant that the product obtained was NOT the desired iodide, since all but the lowest weight iodides are non-inflammable. Several runs were made using the butyl alcohol, all yielding the same results.

A series of exhaustive tests were made upon the mysterious distillate, the results of which are below.

(1) A determination of the boiling point was made and found to be 70-75 C.

(2) The fluid was fused with metallic sodium and the resulting salt dissolved in water. Qualitative anion analysis was made (see *Semimicro Qualitative Analysis* by Caldwell and King, pages 41-57 and *Identification of Organic Compounds* by Shriner and Fuson, pages 112-116 for procedure) and only iodine was found to be present.

(3) The brownish liquid's reaction

with sodium was carefully studied. When sodium was first added, a reaction took place (a) the liquid became clear and (b) a gas was given off. In all respects the liquid was the same after the reaction as before it except for color.

(4) The liquid was ignited and burned with a smoky flame.

(5) A dark-red, non-inflammable liquid, heavier than water, was left after ignition.

(6) This dark-red liquid (dissolved in dry ether) reacted with sodium to produce a gas and a salt identified as NaI (see *Semimicro Qualitative Analysis* and *Organic Chemistry* by Norris pages 243 and 35 for details).

(7) The clear liquid produced in (3) was ignited and burned as before. There was no residual liquid as there was in (5).

(8) The liquid was lighter than water and insoluble in it.

(9) Iodine was added to clear liquid (3) and shaken — brown color remained even on heating.

(10) Tests for aldehydes and ketones yielded negative results (see *Organic Chemistry*, pages 193-194 and 200 for tests).

(11) Compound reacted with cold concentrated sulfuric acid with the evolution of hydrogen sulfide.

Conclusions

Observations (1), (3) and (5) indicate that the substance is probably a mixture. Observation (7) confirms this conclusion.

Observation (5) indicates that one of the components of the mixture might be the required iodide. This is confirmed by observation (6).

Then we have the iodide dissolved

in some unknown by-product of the first reaction carried out.

Observation (4) indicates either:

a) an unsaturated compound. This is denied by observation (9).

b) an aromatic compound. This is impossible in view of the starting products of the reaction.

Or,

c) A higher molecular weight alcohol, ketone, ether, aldehyde, acid, or hydrocarbon.

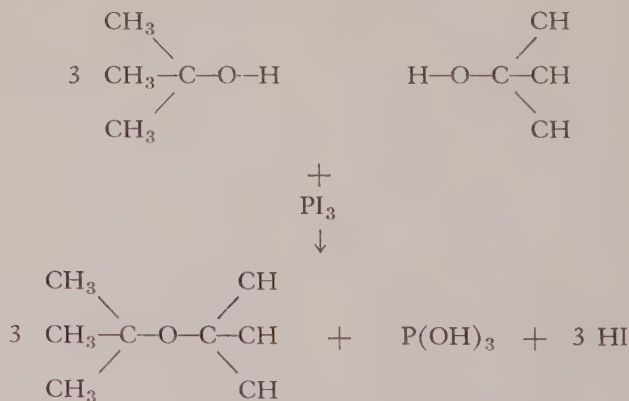
Observation (3) rules out com-

pounds containing a hydroxyl group namely acids and alcohols.

These facts suggested test (10) which rules out ketones and aldehydes leaving only ethers and hydrocarbons.

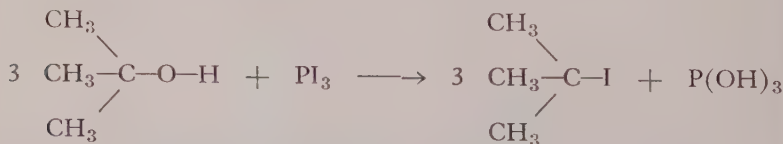
Since the unsaturated hydrocarbons react with iodine slowly (if at all) the field had to be widened to include saturated and unsaturated hydrocarbons and higher molecular weight ethers. Assuming that both a hydrocarbon and an ether were present, the following is a possible explanation of what happened:

Production of an ether

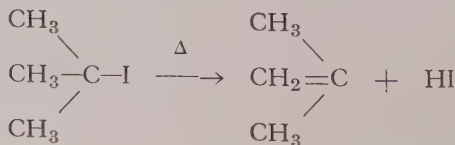


Production of an unsaturated hydrocarbon

First, the iodide was produced:



Which then passed into iso-butylene with the elimination of hydrogen iodide:



It will also be noted that the boiling point of the liquid (concluded to be a mixture of iso-butylene, tertiary amyl iodide, and a complex ether) closely corresponds to an average of the temperatures of the boiling points of its constituents.*

Future Work

Although the attempt to prepare a higher member of the acid series was a partial failure, it seems likely that, with further work, success can be obtained. If this is true and a method of reconverting the byproducts into useful products could be found, the process might have potential industrial significance.

Note

In a report such as this where brevity is of the utmost importance, it is impossible to give a true picture of the work actually done.

This project represents approximately 3 years of intensive background study and over 3 months of laboratory work. Many necessary details have been omitted.

For instance, in the identification of the ether in the last synthesis, no men-

Since this complex ether has never been prepared before and is not listed in the literature, an exact boiling point is not available. However from a study of the series, it can be concluded that it is above 100°C.

tion was made of the many fruitless tests carried out. At one time this liquid was believed to be the iodide of a complex acid. Since this iodide had never been prepared before and its properties were not listed in the literature, it was necessary to devise a separate synthesis and to prepare this new iodide. Its properties were compared with the unknown liquid and found to be entirely different. The actual theory of what took place during the last synthesis involves pages of equations and side reactions, ending with a concrete method to overcome the difficulty. Only two representative equations from this theory could be given in this report.

The entire synthesis as presented in this report was completely worked out (in theory) before any attempt was made to begin actual laboratory work. The original papers are available on request. The by-products and intermediate steps were too numerous to include in this report, but actual samples from the process are mounted on a board in a flow chart. A picture of the board is available on request and the board is available to inspection by all.

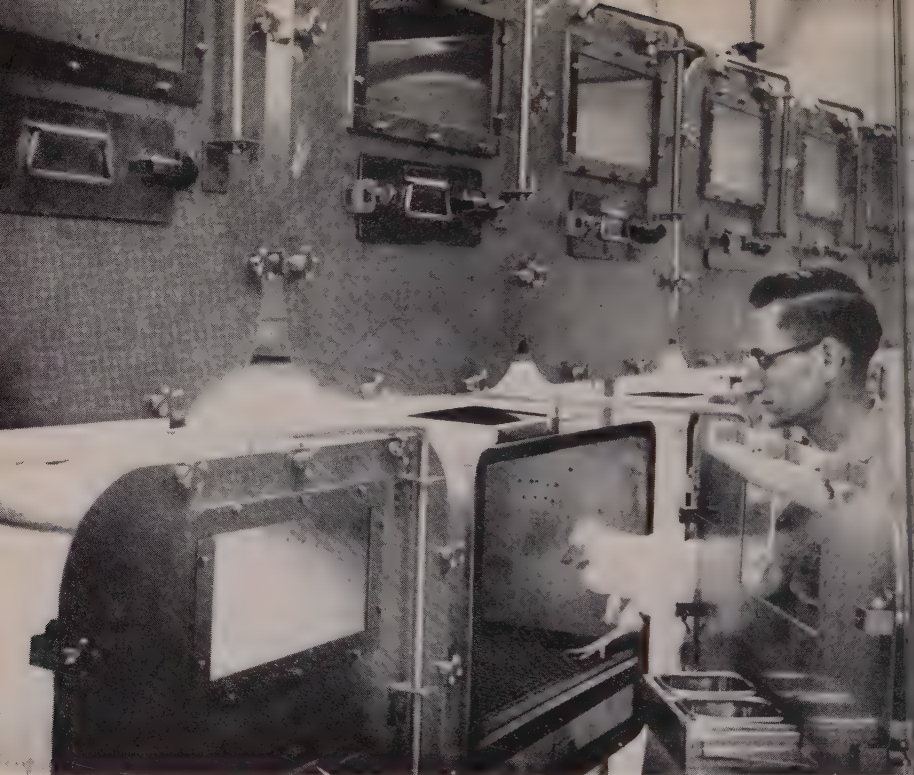
Most of the work in this report can be found in no reference book. As far as the author is concerned, all work is original.

Radioactivity Manual

AN INTERNATIONAL manual on the safe handling of radioactive chemicals for all laboratories and hospitals using the potentially dangerous materials is now available. The recommendations contained in the volume are the work of an international panel of experts from 11 countries, including

Dr. F. Western of the Atomic Energy Commission.

The manual is the first publication of the new International Atomic Energy Agency in Vienna. It is available from International Publications, Inc., distributors for the United States and Canada.



➤ SPECIAL ISOLATION UNITS make it possible for Lilly research veterinarians to study many kinds of infectious animal diseases simultaneously in the same room. Controlled air pressure in each of the stainless steel units prevents cross contamination and spread of diseases.

Research for Agriculture

➤ ADVANCES and new products in the fields of animal nutrition, plant science, and veterinary science are the aims of the Eli Lilly Agricultural Research Center. Contributing to these aims are important new additions to the Center, opened this past summer.

The role of agricultural research has become increasingly important here in the U. S. as industry, both governmental and private, strives for

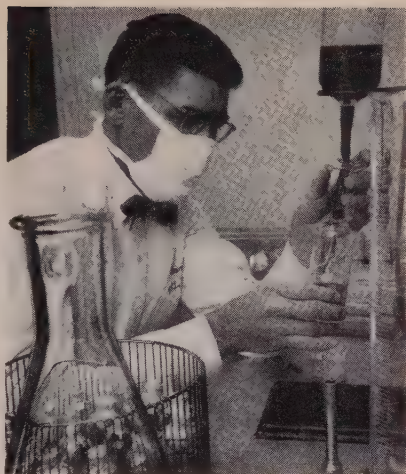
higher productivity and higher standards of living. From research will come the translation of basic knowledge into practical application for the farmer.

By improving feed utilization, altering glandular activity, lessening physiological stresses, and other means, the Lilly researchers hope to produce higher quality meat, milk, eggs, and wool. At the Center also, nutritionist

... studying the effects of antibiotics and chemicals on the quality of these products. Tests are also made to insure the safety of the edible products.

The plant science laboratories are designed for controlled experimentation. Chemicals potentially valuable for controlling diseases, insects, or weeds are first screened in the laboratory or green house. Compounds showing promise in initial tests are then checked in field plots, permitting assessment under more natural conditions. Some of the greatest challenges in agricultural research lie in the field of chemical controls. Insects, diseases, and weeds still cause multibillion-dollar losses annually, reducing national productivity.

The long list of highly infectious animal diseases still to be conquered is testimony to the need for research. The emphasis in veterinary research at the Center is placed on the prevention of these diseases. Microbiologists study infectious agents and the effects of drugs on these agents. Pharmacologists determine the effects of chemicals on laboratory animals, and parasitologists examine the relationship of host to parasite and work



➤ *TISSUE CULTURE, the technique of growing viruses on live animal cell cultures, is being used to develop animal vaccines. Several rooms in the Lilly veterinary laboratories provide sterile conditions for growth and maintenance of cell cultures.*

for improved means of controlling parasites.

The new additions are at the Agricultural Research Center in Greenfield, Indiana. The seven buildings were dedicated on June 17.

Space-Going Rockets have TV "Eye"

NOW SPACE-GOING rockets can have their own TV eye. A nine-pound battery-powered TV system developed at Sunnyvale, Calif., will transmit clear pictures back to earth when rocketed 1000 miles high.

Lockheed Missiles and Space division officials say first units already have been delivered to the Army Ballistic Missile Agency, although this

system was not developed specifically for a satellite program.

Possible TV system applications include showing separation of rocket stages, and ultimately how man is surviving his ride into space. The system, believed to have commercial possibilities also, paints pictures on the receiving screen with 500 lines, far superior to home TV sets.

Oxidize Titanium Metal

Scientists have proven that, contrary to expectations, solid titanium can ignite and burn rapidly under certain conditions.

➤ A PREVIOUSLY unknown property of titanium, important to its technology, has been discovered in an investigation conducted by Stanford Research Institute. SRI scientists have found that titanium metal can oxidize very rapidly under mild conditions provided only that a fresh metal surface is formed to initiate the reaction. Chemists have known for a long time that titanium in finely divided form is rapidly oxidized.

Recent experiments at Oak Ridge National Laboratory — in which a titanium valve operating in an aqueous solution containing oxygen was partially destroyed during normal operation — initiated an investigation which has ended with the finding that massive titanium shapes can ignite and burn up just as does finely divided titanium.

At Oak Ridge, the valve in question was in a test loop containing a hot, pressurized, aqueous solution with oxygen being bled in. In some runs, parts of the valve surface disappeared; in others, this did not occur.

ORNL asked SRI to find out what was happening. SRI gave the job to Edwin Kinderman, Frank Church, and Fred Littman. And this is what they found:

- Under static conditions, titanium will spontaneously ignite when it is in pure oxygen at pressures of 350 psi or more — but only if fresh sur-



➤ BEFORE-AND-AFTER examples show what happens to titanium rods as the result of auto-ignition, the property investigated by the Physical Sciences Division at Stanford Research Institute.

face is created in some way, such as breaking a tensile specimen. If the oxygen is diluted with helium, or other gaseous diluent (even steam), the total pressure required goes higher as oxygen level goes lower until at 35% O₂ or less, the reaction no longer occurs no matter how high the pressure. This means that you will never find titanium burning itself up in air at any pressure unless you enrich the air's O₂ content.

- Under dynamic conditions (such as breaking a rupture disk), the same

ction occurs, but oxygen levels did not be as high as when the atmosphere is not moving past the titanium. For example, titanium will ignite in pure oxygen moving past it when total pressure is as low as 50 mm. Again, limiting O_2 level is about

10%. In both of these cases, temperature is not important, in the 20° to 300° C. range.

Once the reactions are started, they will propagate in atmospheres with much lower O_2 levels than are needed to start them. And steam as a catalyst acts as an auxiliary source of oxygen, allowing the reaction to go at lower O_2 levels.

Kinderman, Church and Littman took some high speed fire motion pictures of these oxidation reactions. They found that while the reactions are rapid they were not explosive and that the burning of titanium was a very smooth reaction. From these pictures and from the accumulated data, they have come up with the mechanism for the reaction.

This is it: When a fresh titanium surface is exposed to an O_2 atmosphere, it oxidizes rapidly and exo-

thermically. Rate of oxidation is dependent on O_2 pressure and concentration. If rate is high enough so heat is formed faster than it can be conducted away, then the surface heats up until it melts. If this happens — and only if this happens — the reaction becomes self-sustaining and continues until either the titanium or the oxygen runs out. The reason: Above the melting point, the oxides rapidly diffuse into the titanium interior, allowing fresh molten titanium to come to the surface and react.

This then means that, for a metal to autoignite, it must meet two conditions — energy must be released faster than it can be carried away; oxides have to be soluble in the molten metal.

To check these points, the SRI group tested zirconium, whose oxides are soluble in the molten metal, and aluminum, magnesium, tantalum, and niobium whose oxides are not soluble. Only zirconium ignited.

This is an indirect proof of the mechanism, the SRI team realizes. Other research is in progress which should give more direct evidence for the theory.

Plastic Spray Aids Fingerprinting

A PLASTIC SPRAY has been found to produce more sharply defined reproductions of latent fingerprints than methods now in use by investigating agencies.

The film produced by spraying the quick-drying, almost indestructible plastic over a dusted print can be

readily stripped from the object sprayed and can be stored indefinitely.

The spray was developed by Atlantic Research Corporation in Alexandria, Va., under a U. S. Army Quartermaster Corps contract. The Army believes the new technique can also be used as an additional method for the identification of war dead.

Bombs Create More Carbon-14

➤ MAN'S NUCLEAR bombs have produced radioactive carbon-14 in the earth's atmosphere 15 times faster than nature during the past four years.

This radioactive carbon becomes a part of the human body about a year after it enters the atmosphere for persons living in the United States. Radiocarbon-14 has been indicted by Nobel Prize-winner Dr. Linus Pauling of California Institute of Technology and other scientists as considerably more dangerous to humans, genetically, than radioactive strontium-90.

Four scientists from Columbia University's Lamont Geological Observatory report on their survey of bomb-produced radiocarbon in two related articles in *Science* (Aug. 7).

Neutrons released during nuclear tests react with nitrogen to give "man-made" carbon-14 as part of the carbon dioxide in the atmosphere. Dr. Wallace C. Broecker and his associates measured the bomb-produced

radiocarbon in the oceans and the human body as well as in the air.

They found that the carbon-14 concentration in the lower part of the atmosphere increased about five percent each year between March, 1957 and March, 1958. Mixing of air between the Northern and Southern Hemispheres is so rapid that it is complete within two years.

Only about 10% of the radiocarbon-14 produced up to March, 1958, has entered the oceans. When this radioactive material becomes distributed throughout the atmosphere and the oceans, the amount in the air will be between one-quarter to about one and a half percent higher than in the pre-bomb days. This added amount will then decrease, half of it being eliminated in 5,600 years.

Dr. Arthur Schulert and Edwin A. Olson of Lamont Observatory, and Dr. Alan Walton, now at the National Physical Laboratory, Teddington, England, cooperated with Dr. Broecker in the survey.

Cell Grows with Chemical "Meal"

➤ RESEARCHERS have handed the biologists and chemists a menu for mammalian cells.

New scientists should be able to determine directly differences in food requirements for normal and cancer cells, and different ways the cells use various nutrients. It may also be possible to arrest the growth of malignant cells by merely changing their diet or by introducing cancer-specific poisons.

Instead of "feeding" mouse cells with expensive and relatively unidentified substances such as blood serum, embryo juices and proteins, Dr. Charity Waymouth of the Roscoe B. Jackson Memorial Laboratory is using a culture medium of 40 completely defined ingredients. This chemical solution, costing about \$1.25 a quart, is supporting an "almost explosive growth of mouse cells."

The medium contains, among other

compounds, table salt, potassium bromide, calcium chloride, magnesium chloride, dextrose, nine vitamins and 16 L-form amino acids.

Development of the synthetic medium is the result of more than seven years of research. Dr. Waymouth gradually altered the proportions of known chemicals in the culture medium she used to grow mouse cells, moving first the blood serum and then the proteins and protein fragments called peptones.

For more than a year, she said, the

mouse cells have been growing on the 40 simple compounds. Each week the number of cells increases seven- or eight-fold.

However, the cells appear to thrive on other diets, Dr. Waymouth reported. She will continue to study possible simpler and better nutrient mediums.

The study was supported by an American Cancer Society grant made to Dr. Philip R. White of the Jackson Laboratory. Dr. Waymouth is a research associate of Dr. White.

Deionized Water Cools Aluminum

A 96,000-GALLON TANK of deionized water is being used to quench, or cool, hot aluminum extrusions without the risk of staining their surfaces. The extrusions, which are loaded into a 70-foot-high heat-treating furnace and subjected to temperatures up to 980 degrees Fahrenheit, must be cooled quickly in a solution that will not stain the metal surface.

Ordinary water, containing a variety of potentially corrosive ions, cannot be used. Instead, deionized water must be used.

The special quench tank, 56 feet in diameter, was built directly under the

furnace at the Reynolds Metals Company plant, Grand Rapids, Mich., so that hot extrusions could be lowered into the bath in the shortest time.

Water deionized with Amberlite ion exchange resins, made by the Rohm & Haas Company, Philadelphia, is supplied to the tank from a multiple-bed ion exchange system.

This high-quality water is rated at three-parts-per-million dissolved solids and has an electrical resistance of 200,000 ohms. It protects the aluminum from stain by the quench, keeping the surface clean for further finishing.

Synthetic Jet Engine Oil

A SYNTHETIC jet engine oil that withstands temperatures of 400 degrees Fahrenheit will enable designers to squeeze more performance out of their machines in the future.

The new lubricant is an ester type of fluid having additives — among them, a silicon-containing analogue of phenothiazine. Developed by Air Re-

search and Development Command jointly with Celanese Corporation of America, the oil has withstood 400-degree temperatures for "sustained periods." Present lubricants are good only to the 300-degree Fahrenheit range, the Air Force said, and cannot be used in some of the future's hot-running high-performance aircraft.

Table for Abundance of Elements

➤ A TABLE for the abundances of all the chemical elements has been drawn up by a Canadian scientist.

His revision of previous estimates on the proportions of the 92 naturally occurring elements is based partly on the thermonuclear reactions by which stars are stoked. Dr. A. G. W. Cameron of Atomic Energy of Canada Ltd., Chalk River, Ontario, found that many of the prior figures for abundances did not have to be revised at all.

Hydrogen, for instance, is still the most abundant element, although Dr. Cameron finds it not quite so prevalent as others have thought. Next most abundant is helium, followed by oxygen, carbon, nitrogen and silicon.

However, in the rare earth region, the 15 elements of atomic numbers 57 to 71, substantial changes were

made. Dr. Cameron's table is a revision of one reported by Drs. H. Suess and H. C. Urey, both now at Scripps Institution of Oceanography, La Jolla, Calif. Their table was based on abundances as found in meteorites.

Dr. Cameron's new table is the result of investigating the nuclear reactions that accompany the burning up of carbon by thermonuclear reactions in hot stars. It was reported in the *Astrophysical Journal*, published by the University of Chicago.

When a star is formed out of the gas and dust in interstellar space, it consists mostly of the light gas, hydrogen, the most abundant element. As the star's center heats up, the hydrogen is converted into helium. After the hydrogen is exhausted, the helium is changed to carbon by a new set of thermonuclear reactions.

Earth's Core not Pure Iron

➤ EARTH'S CORE is not made of pure iron, as many scientists believe, but contains "significant amounts" of lighter weight elements, the American Geophysical Union was told.

Drs. Leon Knopoff and Gordon J. F. MacDonald of the University of California, Los Angeles, said the new make-up for the earth's center is based on Russian measurements of the compressibility of iron and eight other metals at extremely high pressures.

They reported that the density of iron at the pressure believed to exist at the boundary between the core and the mantle is 11.8, whereas the density of the material at the core bound-

dary is estimated to be between nine and ten.

This difference can only be resolved by assuming that the core is not pure iron, they reported, but contains alloying elements of lower atomic number than iron. The rate at which earthquake waves travel through pure iron at the pressure of the earth's core is also significantly different from that observed, indicating the presence of light materials.

A material with a mean atomic number of 23 in the core is consistent with earthquake wave observations and density measurements, Dr. Knopoff and MacDonald concluded.

Fluorine Chemistry Widens

Chemists describe a new general preparation for fluorine substituted organic compounds.

A UNIQUE chemical compound, whose very existence was doubted in scientific circles until recently, has been developed.

The new product, sulfur tetrafluoride, is a reactive gas which, unlike other reagents, possesses the unusual ability of replacing oxygen with fluorine in many chemical compounds. In light of the widespread interest in fluorinated products in recent years, this "unusual ability" is particularly significant since it will now be possible to offer a large number of fluorinated compounds heretofore unavailable.

The new chemistry of sulfur tetrafluoride is credited in large measure to three research chemists, Dr. Earl Muetterties, Dr. William Chang Smith, and Dr. Charles W. Tullock, all members of the Central Research Department at E. I. du Pont de Nemours and Co.

Opening up a whole new range of actively fluorinated products, sulfur tetrafluoride appears to be of particular interest in pharmaceutical products, where addition of fluorine has been known to result in drugs of high efficacy. The ability of fluorine to increase or modify biological activity of other chemicals might also lead to better insecticides and herbicides, Du Pont chemists think.

Other uses of the fluorinating agent might be in production of improved weather-resistant finishes, and oils,

films, plastics, and elastomers with high thermal stability and resistance to oxidation. The low surface energy characteristic of many fluorinated compounds also suggests use of sulfur tetrafluoride in manufacture of surface-active agents, water and oil repellents, and lubricants.

While much remains to be learned about the chemistry of the compound, Du Pont chemists said their studies show sulfur tetrafluoride can be reacted effectively with a variety of carboxylic acids and carbonyl compounds, including aldehydes, ketones, and quinones to produce new fluorine-containing products or greatly simplify the manufacturing processes involved in existing products.

Discovery of the means to synthesize sulfur tetrafluoride illustrates the working of present-day fundamental research. Dr. Muetterties, his curiosity challenged by fragmentary references to sulfur tetrafluoride in the chemical literature, set out to see whether the compound could actually be synthesized. When these efforts proved successful, Dr. Smith undertook research to find out what the new compound could be reacted with and to determine some of its practical applications. Much of this new chemical knowledge is the result of his work. Dr. Tullock's contribution was in exploring new kinds of fluorinating reactions and discovering a commercially feasible method of production.

Progress in Forest Genetics

by DR. BRUCE J. ZOBEL

➤ THE POSSIBILITY for widespread use of genetics in forestry has only recently been recognized. During the past seven years progress has been very rapid, so much so that in many instances the demand for practical application of genetics has surpassed the existing body of fundamental knowledge on which sound practices must be based.

A number of research organizations are now engaged in both the basic and applied phases of forest genetics. There is at present a good balance of investigative effort in which the forestry schools, the Federal and State Forest Services, and private industry are all taking a part. The pulp and paper industry, especially in the South, has been a leader in sponsoring research. At present the southern industries are sponsoring programs at the University of Florida, North Carolina State College, and Texas A & M College.

Although progress has been rapid beyond the highest hopes of most researchers, forest genetic investigations are still a long-term, slow undertaking. Some of the most important basic studies to date deal with ways to find short-cuts for speeding up both research and application. Methods to induce early seed production are being worked on. Already some juvenile-mature relationships, especially on wood properties, have been worked out, enabling prediction of the characters of a mature tree from the characters of the young tree or seedling. Wherever such juvenile-mature rela-

tionships can be established, the progress of forest genetics is greatly speeded up.

Applied Research

Basic studies on pest resistance, physiology, and growth patterns are now underway. These serve as a basis for all applied research. For example, real success in determining the genetic control of wood specific gravity cannot be achieved until we understand why a tree stops producing spring wood with its thin-walled tracheids and starts producing summerwood with its thicker-walled tracheids. In fact, most of the basic studies now needed, and already underway are not really forest genetics at all, but they are basic to further progress in the field.

In the South, the greatest applied effort has been directed to improvement of seed source for planting. The initial work has largely centered on the selection of trees to be used in special seed-producing areas called seed orchards.

Seed orchards are established from the best-appearing trees to be found in the forests. These are then tested for their genetic superiority while the orchard grows. As soon as the genetic tests are completed, the genetically poor individuals are removed from the seed orchard.

Many acres of seed orchards for the southern yellow pines have been established within the past five years. Most of the larger companies have either established, or are establishing sufficient acreage of seed orchards

ply seeds for all their planting
ds in the future. Enough slash and
olly pine seed orchards have al-
dy been established to supply seed
production of about 300 million
ntable seedlings annually, and the
d orchard acreage is expanding
idly, both in industry and state
grams.

ed Sources

Trees to be used as seed sources are
iously called *selected* trees, *plus*
es, *super* trees, or *superior* trees.
ey are the very best available in
present forests. They may be se-
ed for one or more outstanding
characteristics — usually for a com-
ation of several characteristics. Su-
iority is judged on the basis of
owth rate (both in height and in
meter), limb size, straightness of
e, rapidity of natural pruning, free-
n from diseases and insects, and
ality of wood. Such “super” trees
e hard to find in the forest, but
ey do exist.

It should be stressed that super trees
y appear to be excellent individ-
ls, yet their real value lies in the
gree to which they pass their out-
nding characteristics to their off-
ring. This is why genetic tests are
ecessary to assess their value in the
ed orchard.

Unfortunately, as yet we know very
le about heritability patterns in
es. Unquestionably, some charac-
istics are passed very strongly from
rent to offspring, while others may
largely controlled by the environ-
ent in which the seed germinates
d the tree grows. As soon as this
eritance pattern can be determined,
est genetics will take tremendous
ides ahead.

No Super Tree

No one is hunting for a “super
tree, excellent in all characteristics,
capable of growing under all condi-
tions, with wood best suited for all
products.” Such trees do not exist.
The forest geneticist hopes to find a
tree best for the Piedmont, or for the
Coastal Plain, best for North Carolina
or Texas — a tree whose wood is best
for kraft or for newsprint. But no one
tree can be best for all purposes or
situations. The forest geneticist is
fully aware of this lack of universal
suitability of any single strain; he
therefore, is trying to tailor-make a
tree most suitable to grow in one area,
on one site, with wood best for one
product. Another tree must be de-
veloped for another place or a differ-
ent set of conditions.

Hardwoods Neglected

One major shortcoming so far with
the forest genetic studies in the South
has been the emphasis on pine to the
almost complete neglect of hard-
woods. Since pine is generally consid-
ered the more valuable tree, with the
greatest immediate potential, almost
all industrial emphasis has been on
them. But it would be short-sighted,
indeed, if we failed to start studies on
hardwoods, and start now! It is axio-
matic that basic information must be
built up in advance of applications,
if the latter are to be efficient and
sound. Surely we should learn some-
thing from mistakes in pine improve-
ment where we are now faced with
pressures for application which are
far outstripping the supporting basic
information.

In summary, forest genetics, especi-
ally its applied phases, is relatively
new. It is now receiving great em-

phasis in many quarters, and positive results are being achieved. But the long-term nature of forest genetic studies frequently entails deferred reporting of the ultimate benefits from its application. Also, lack of basic supporting information is seriously retarding progress. However, the concept of forest genetics as a phase of

silviculture is being accepted by practicing foresters. With widespread acceptance, rapid strides in application can be expected. Forest genetics is then, simply another valuable tool available to the silviculturist, and one that will grow in importance as new discoveries show us how best to use this tool.



► HIGH VACUUM UNIT — This apparatus in the new Research and Development laboratory of Engelhard Industries, Inc. in Newark, N. J., measures the surface area of catalysts containing precious metals. The process, which involves nitrogen adsorption at liquid nitrogen temperature, helps to determine the efficiency of catalysts.

Organo-silicon Chemistry

FOR HALF a century scientists have tried to make optically active silicon compounds as a tool for investigating the structure of compounds and the mechanics of chemical reactions involving silicon atoms.

The discovery of a way to make silicon compounds with a high degree of optical activity has been reported in *The Journal of the American Chemical Society* by Dr. Leo H. Sommer and Cecil L. Frye of The Pennsylvania State University College of Chemistry and Physics. These new compounds provide silicone chemists with their most important single tool in studying the stereochemistry of organo-silicon compounds.

Asymmetrical Forms

Confirmation of the special arrangement of organic groups about a single silicon atom hinges on the preparation of structures containing four different groups attached to a central silicon atom and separation of the mixture into its two optical isomers. These asymmetrical forms must be identical in every respect except that one is a mirror image of the other. This mirror-image relation is observed in the rotation of polarized light to the left or to the right depending upon whether the molecule is laevo- or dextro-oriented.

This technique for proving the position of groups around a central atom was first applied to organic compounds by Louis Pasteur in 1848. Five years later he demonstrated the importance of molecular arrangement to the assimilation of compounds by living organisms. He observed that the

dextro-tartaric acid is consumed while identical molecules with a left-handed orientation are rejected by the bacteria that causes fermentation. On these discoveries rests the science of stereochemistry.

Optical Activity

Dr. F. S. Kipping of Nottingham University in England worked for years to make silicon compounds similar to the optically active carbon compounds discovered by Pasteur. This he did in 1907 and by so doing proved that silicon, like carbon, can be the center of optically active asymmetrical molecules. Kipping's compounds were too difficult to prepare and too feeble in their optical activity to use as a device for the further investigation of the structure of molecules based on silicon atoms. Kipping's consuming interest in the silicone analogs of carbon compounds later contributed to the rapid development of the silicone industry in the 1940s.

In the field of organic chemistry optical activity has become more and more an important tool for exploring the structure of compounds and studying the mechanics of chemical reactions. In 1895 optically-active carbon compounds were used by P. Walden to prove that chemical reactions at a carbon atom can involve important spacial rearrangements without changing the basic chemical composition. This was done by proving that reactions may frequently be attended by a complete inversion of the molecular arrangement comparable to the turning inside out of an umbrella by a high wind. Such an understanding of

space chemistry was essential to the synthesis of cortisone, adrenaline and other important pharmaceuticals.

Much of the knowledge of molecular structure gained by organic chemists has been applied during the past twenty years to silicone chemistry. Now, however, for the first time optically active silicon compounds are readily available for exploring the intimate details of chemical reactions at the silicon atom. They have already been used, for example, by Dr. Sommer and Mr. Frye to prove that a Walden inversion of structures does take place in certain reactions involving asymmetrical silicon molecules.

This important contribution to the field of stereochemistry of organosilicon compounds was made by Dr. Sommer and his graduate students working under grants from Dow Corning Corporation of Midland, Michigan. Under an agreement signed in 1947, over a thousand organosilicon compounds have been prepared and analyzed. More than sixty papers have been published on silicone chemistry in *The Journal of the American Chemical Society*. And twenty-five doctorates and twelve master's degrees have been earned for original research in this field under Dow Corning Fellowships.

Cancer Experiments

➤ A NEW APPROACH to basic cancer research and to other cell studies was described by a Michigan State University scientist to the Genetics Society of Canada.

Dr. G. Bernard Wilson and his associate, Dr. John H. Morrison, kept tiny pieces of roots from pea plants alive in a solution of organic salts. The solution kept the cells alive but stopped virtually all reproduction, Dr. Wilson reported.

He said several compounds — notably glucose and many other sugars — would make the cells divide and continue through two or three more reproductive cycles.

An important aspect of the work is the use of the drug, colchicine, to "tag" cells for future identification.

When a cell is treated with colchicine, its chromosomes split, thus doubling in number, and it seemingly goes

through the other stages of reproduction with one important exception — it does not divide. It ends the cycle as one cell with double the usual number of chromosomes.

When colchicine is taken from the medium, the cell will go through the reproductive process again and divide normally. Its "descendants," however, will be obvious under a microscope because each will contain double the usual number of chromosomes.

By counting the "descendants" of colchicine-treated cells in a sample, the number of cycles can be determined which took place since the sample was exposed to the drug.

Since it is not possible to work with individual cells in this sort of research, Dr. Wilson and his associates gain their findings for each experiment through statistical analysis of data from hundreds of samples.

Molten Salts for Reactor Fuel

A BETTER FUEL for high temperature nuclear reactors than the uranium metal rods now in use may be uranium salts which are mixed with molten salts.

As says Dr. Haakon Flood of Norway, an authority on molten salt chemistry, basic also in metallurgy and ceramics.

He is visiting professor of engineering at the University of California, Los Angeles, and also serving as advisor to American atomic installations on chemical problems of fueling reactors with uranium salts.

He explains that uranium metal rods have two major disadvantages. They lose their shape when exposed to radiation from the fission process. And they do not work continuously, so the rods have to be taken out of the reactor to remove impurities caused by fission products.

Reactors using molten uranium salts may overcome these disadvantages. The salts, in liquid form, do not change shape, and can be continuously purified by a cycling process, in which the liquid is pumped out, purified and returned to the reactor.

On the other hand, the use of molten salts raises some new problems, such as finding the proper material for the salt containers. Important investigations along these lines have been reported by the Oak Ridge laboratories.

During this fall semester, Dr. Flood will teach a special UCLA course in high temperature salt chemistry. In his own country, he is professor of inorganic chemistry at the Norwegian Institute of Technology, and head of the Institute of Silicate Science.

Man-Made Cold Rubber

FACILITIES for large volume production of a new man-made cold rubber containing tiny particles of carbon black intimately and uniformly mixed with rubber molecules, has been opened on stream by Goodrich-Gulf Chemicals, Inc., at its Port Neches, Texas, plant.

The equipment is designed to produce 15 million pounds of black masterbatch per month on a continuous basis. Half of styrene-butadiene polymer reactor lines, with their recovery and drying equipment, at the Port Neches plant has been converted to this production.

The new product is being offered to the rubber industry as "Ameripol Micro-Black" masterbatch. According to L. O. Crockett, president of Goodrich-Gulf, black masterbatch will give as much as 15 percent more road life, when used as tire tread and retread stock, than present synthetic rubbers when the reinforcing agent is dry-mixed with the rubber in Banburys. This added tread life, Mr. Crockett said, has been evaluated in laboratories under carefully controlled conditions and by road test conducted among several tire manufacturers.

In addition, Micro-Black's im-

proved abrasion resistance offers wide possibilities for belting, insulation, and molded and extruded products subjected to heavy duty service.

This development comes at a time when the world-wide use of synthetic rubber in all of its many forms is climbing to an all-time high. Last year

in this country alone, the synthetic rubber industry supplied about percent of our total rubber requirements. In 1959, the U. S. consumption of synthetic rubber will approximate 1 million long tons — about double that of the estimated natural rubber demands.

Liquid Methane Crosses Ocean

➤ THE METHANE PIONEER, a converted 5,000-ton dry cargo ship, has made its first delivery of liquid methane to gas-deficient England, successfully completing the first trans-oceanic delivery of liquid methane in the history of navigation.

The ship carried the methane at atmospheric pressure and minus 258 degrees Fahrenheit in special aluminum tanks installed in the hold of the ship. The maiden voyage climaxed five years of research and development by Constock International Methane Ltd., which is owned by Union Stock Yard and Transit Company and the Continental Oil Co. of Houston, Texas.

Methane is the principal compon-

ent of natural gas and liquefies minus 258 degrees Fahrenheit. When it liquefies, it reduces to 1/600th its gaseous volume. It is impractical to hold large amounts of methane as a liquid under pressure, and scientists for years have been studying methods of transporting liquid methane at extremely cold temperatures to avoid the pressure problem.

The voyage is said to mark the beginning of a new era in which natural gas, previously wasted or shut in for want of accessible markets, can be liquefied and transported by tanker to countries where gas is not naturally available and energy must be supplied by gas manufactured from coal or oil at high costs.

Oxidizer Production Boosts Rocket Fuel

➤ GREATER PRODUCTION of one of the essential ingredients of solid rocket fuel will be provided by a new plant being built by HEF, Inc., near Columbus, Miss. The new plant to begin operation in January will be able to produce either ammonium or lithium perchlorate.

Ammonium perchlorate is an oxidizer used in high energy solid fuels for guided missile propulsion. Plant

capacity will be 4,000,000 pounds of ammonium perchlorate a year.

HEF, Inc., is jointly owned by Hooker Chemical Corporation and Foote Mineral Company. The plant is being constructed on property adjacent to Hooker's sodium chlorate manufacturing plant, thus providing a ready source of the basic raw material for both ammonium and lithium perchlorate.

Plastic Artificial Moon

A PLASTIC artificial earth satellite is used to relay radio and television signals around the world and help sailors chart their courses was described at the Aviation Conference of the American Society of Mechanical Engineers.

The sphere would be hurled 1,000 miles into space in a deflated state. Once there, a one-pound container of gas would inflate the sphere for its orbital journey.

The versatile moon would be covered with a thin film of vapor-deposited aluminum. This would make it visible on earth and provide a good

reflecting surface, protecting it from prolonged exposure to the sun's rays.

The sphere's prototype, reported George P. Wood and Arlen F. Carter, aeronautical research engineers at the National Aeronautics and Space Administration's Langley Research Center in Virginia, would be 100 feet wide and weigh about 100 pounds.

The engineers estimate that between 10 kilowatts and 10 megawatts should be enough power to shoot radar beams to the satellite.

The bright aluminum surface, they said, would make the proposed space outpost far brighter than all but two stars and four planets.

Portable Aluminum Sphere

THE OVEN of the future may be a portable aluminum sphere designed to be used wherever needed — at your dinner table, or in your patio.

This prediction is embodied in a spherical aluminum oven created by industrial designer Greta Magnusson Grossman for the Aluminum Company of America.

The oven's heat source could be the conventional electric stove resistance

unit. But less conventional sources could be used also, such as infrared or quartz light, solar, ultrasonic or induced heat.

The oven can be used to broil or bake in right at the table. It has two half-spheres circulating around each other. When open, the shelves are fully exposed. The carrying handle also serves to turn the outer shell, opening or closing the oven.

New Lead Alloy Foreseen

FINELY DIVIDED metals mixed with molten lead may produce a new class of useful metallic materials, Battelle Memorial Institute has announced. The new alloys will combine the advantages of lead with those of the hard substance. The corrosion resistance of soft lead, for instance,

might be better utilized when the lead is combined with a tougher metal.

The Battelle investigators have found six metals — cobalt, copper, iron, molybdenum, nickel and tungsten — particularly well suited for the new alloys.

Silicone Compounds for Insulators

➤ A NEW grease-like silicone compound may increase the dependability of electrical systems.

Simply wiping one coat of the material onto line insulators may protect the insulators up to three years and be effective in preventing fires and flashovers, W. A. Reece of Dow Chemical Company, Midland, Mich., told the American Institute of Electrical Engineers.

Mr. Reece said that during the past

year Dow has used the compound "with very good results."

Whereas fires and flashovers on 2,300- and 13,800-volt lines have given Dow trouble in the past, none has occurred since Dow insulators were treated with the new compound.

Mixed with graphite, he said, the compound also "almost eliminated dirt and corrosion from 300-volt direct current crane rails and trolley. Graphite is used to make the compound more conductive.

Borax Will Help Provide Jet Fuel

➤ VOLUME PRODUCTION of special liquid fuel made from borax and other materials will soon be under way for Navy jet planes.

The high-energy fuel will be created in tonnage quantities at "Project Zip," a \$38,000,000 facility built by Callery Chemical Company which will operate it for the Navy. It is the nation's first large-scale plant to make big quantities of the fuel.

The product is named HiCal and will be created from sodium, hydrogen, ethylene, and derivatives of the

same borax used in homes. The borax is processed into diborane, the foundation of boron-based fuels.

In a dedication address Rear Admiral Robert E. Dixon, chief of the Navy Bureau of Aeronautics, said the Navy hopes to make the new fuel available later for commercial use.

"Project Zip" was begun five years ago to provide a fuel which would permit Navy jet planes and missiles to fly farther and faster with bigger payloads.

Steel Waste Aids Crops

➤ FERROSUL, a waste material of steel manufacture, shows promise as a source of trace minerals for growing crops on soils where these minerals are lacking. Plants were grown in a greenhouse using ferrosul to provide calcium, sulfur, magnesium, iron and manganese, J. L. Stroehlein and K.

C. Perger of the University of Wisconsin have reported.

Plants were unharmed as long as "extremely large quantities" of material were not applied to the soil. Even the use of ferrosul, which is not commercially available, needs more study, the researchers indicated.

Cosmic Rays Linked to Weather

A LINK between the weather and cosmic rays bombarding earth in space has been suggested by a S. scientist.

Dr. Edward P. Ney of the University of Minnesota believes weathermen should investigate whether changes in cosmic radiation cause variations in weather. He said such effects could occur through the indirect route of atmospheric ionization.

Dr. Ney said that part of his suggested link is well established, part in speculation. Well known is the fact that high solar activity, when the sun is at the peak in its 11-year cycle, as present, results in low levels of cosmic radiation.

This, in turn, is known to decrease the amount of atmospheric ionization,

since cosmic rays electrically charge the air through which they pass.

This decreased ionization, Dr. Ney then speculates, could lower the air's electrical conductivity, making it a better insulator. This, in turn, might increase the build-up of electric fields and thereby increase storminess. The increased cloud cover associated with the thunderstorms would produce extra cooling of earth and, therefore, a lower mean temperature at sunspot maximum.

Carefully labeling his theory as speculation, Dr. Ney urges weathermen to look for other patterns besides temperature changes that might be used to test his cosmic ray-weather variation idea. The suggested chain of events is outlined in the British scientific journal, *Nature*.

Polar Radio Blackouts

TRILLIONS upon trillions of wandering free electrons in the lowest layer of the ionosphere probably cause the polar radio blackouts that disrupt communications in Arctic regions.

Man's activities, and his safety, in the Arctic depend greatly on reliable radio contact, which sometimes becomes impossible on any frequency. Each time disrupted communications occur when radio waves are completely absorbed in the ionosphere, the electrically charged layer of the upper atmosphere that reflects radio waves.

Drs. J. C. Seddon and J. E. Jackson of the U. S. Naval Research Laboratory reported to the U. S. National

Committee for the International Geophysical Year (IGY) that the first measurements of electron density during a polar radio blackout were made by two rockets launched from Fort Churchill, Canada. Information telemetered earthward from these two rocket flights, plus a third, furnish "very strong evidence that a polar blackout is due to an abnormal number of free electrons in the D-region of the ionosphere."

They also report that moving electric charges play an important role in this effect. The polar blackout seems to involve little change in the E- and F-regions of the daytime ionosphere.

A-Powered Surface Ships

➤ EXPERIMENTS with models have led investigators to believe that radioactive wastes of atom-powered surface ships can be disposed of safely at sea.

Richard H. Snow and Jan Rosinski, Armour Research Foundation, Chicago, told the American Institute of Chemical Engineers that dispersion of radioactive fission products may be "accomplished largely by the mixing action of the propeller." Further natural turbulence of the sea, they said, would diffuse the waste even more.

The "hot" wastes would come from the ship's reactor, and will consist of "bulky fractions of fission products which are not economically reprocessable."

The men said fish probably would not be dangerously contaminated, and, anyway, the "likelihood that individuals will eat only fish which have

lived much of their lives in the wake of nuclear-powered ships is extremely remote.

"Microscopic organisms which serve as food for fish may rapidly become contaminated in local regions of the sea," they said, "but they will be dispersed by the natural turbulence of the water about as fast as the waste itself is dispersed." Thus, they concluded, "it is unlikely that fish will eat mainly contaminated microorganisms and thereby become contaminated."

Fuels for supersonic airplanes and missiles are expected to cost more than the present price of jet fuels. These hydrocarbon fuels may cost five to ten times as much, the Institute was told by Ernest E. Donath and Martin Hess, Koppers Company, Pittsburgh, Pa.

Ion Device Tops Transistors

➤ A "LIQUID" electronic device that is said to outperform tubes and transistors in special low-frequency applications has been developed to replace, in some cases, whole circuit assemblies. Known as a solion, it carries the electric charge in a solution of ions, in

contrast to electron tubes and transistors in which electrons transport the charge. National Carbon Company, New York, reports that an electrochemical reaction at the electrode causes a current change in an external circuit.

Mineral Exploration Urged

➤ THE MINERALS needed for a long "cold war," or for several centuries in the future, can come from better methods of exploration, superior man-made substitutes and improved extraction techniques using cheap energy sources.

Dr. John A. S. Adams, associate professor of geochemistry at Rice Institute, Houston, called for intensified research on ways to explore for minerals at a public lecture in Washington sponsored by Resources for the Future, Inc.

Red China Ups Aluminum

FURTHER EVIDENCE that Red China looks to become a major world power revealed by its heavy development of aluminum resources.

K. P. Wang, Far East specialist for U. S. Bureau of Mines, reports that Communist China has a small, integrated aluminum industry now in process of rapid expansion. In 1958, he reported, Red China probably produced about 27,000 metric tons of primary ingot. The goal for 1962 is 100,000 to 120,000 tons. Aluminum output may rise to 180,000 tons by 1965, Mr. Wang said.

This is still a long way from U. S. production of 1,647,710 short tons in 1957. But if Red China achieves its 1965 goal, it will have expanded aluminum production by 660% in seven years, an impressive gain. The U. S. expanded its output from 206,280 to 1,647,710 short tons between 1940 and 1957, representing an 800% gain over a 17-year period).

Thus Communist China is about to become a medium producer of aluminum by world standards. In

1959, its output most likely will exceed that of the United Kingdom," Mr. Wang reported in *Engineering and Mining Journal* (July).

The Reds estimate 250,000 to 300,000 metric tons of aluminum are required by the country's economy for every 10,000,000 tons of steel. Annual steel output has already topped that figure. The country is making up some of its deficit in aluminum through imports, Mr. Wang said.

The Chinese are not using aluminum for kitchen utensils and foil, but are harnessing it to industrial jobs where it can work for national advancement. Chief uses of aluminum now are in machinery and equipment, electric power, communications and, to some extent, the automobile and aircraft industries, Mr. Wang reported.

Red China recently determined to expand its electric power distribution system and communications networks by substituting aluminum for 60% of the copper that would be required.

Lithium Found in Atmosphere

LITHIUM, used for making hydrogen bombs, has now been found high in the atmosphere over the Northern Hemisphere for the first known time. Source of the lithium has not yet been determined but many scientists have blamed its presence in the Southern Hemisphere on the hydrogen bomb tests conducted in the South Pacific by the U. S. Other speculative sources named have been meteors and the evaporation of sea water.

Dr. A. Vallance Jones of the University of Saskatchewan in Canada reported that he found evidence of lithium in the upper atmosphere near Saskatoon during the period Jan. 10 to 29. The hydrogen bomb element could have come from nuclear explosions, he reported in *Nature* (May 9).

However, Dr. Jones pointed out, a sea water or meteoric origin must also be considered possible until further measurements have been made.

Chemistry Comments

Continuing our teaser column of interesting facts
in the chemical world.

- Purified silica, which is a derivative of sand, and purified kaolin, a derivative of clay, are replacing the traditional carbon blacks as reinforcing agents in such products as waterproof footwear.
- Magnesium is a vital element in plant nutrition, and a deficiency results in a change in leaf color.
- A thermoelectric refrigerator has been developed which produces cold directly from electricity with no moving parts, noise, or vibration.
- It is theoretically possible by the use of certain chemicals in conjunction with gamma radiation to induce cross-linking or polymerization of the fibers of softwoods, and thereby secure the equivalent of hardwoods.
- The most probable breakthrough in the engineering area of solar utilization are likely to occur in energy storage systems.
- Water with organic materials added to make it more viscous and more opaque, puts out fires 10 times faster than ordinary water.
- The melting of ice along the Antarctic coast in the summer causes a rapid decrease in the saltiness of the neighboring sea.
- Plastic foams made with castor oil may range in texture from soft and spongy to hard and rigid.
- Plutonium-239, a primary ingredient of A-bombs and nuclear reactors, is now being used to measure the moisture content of molding sand.
- A modified plastic was developed especially for use with fibrous glass and asbestos reinforcements to make radomes for supersonic aircraft.
- Film-forming materials recently made from soybean and linseed oil are potentially promising as adhesives and as concrete and masonry paints.
- A nuclear-ionic propulsion system for spacecraft with the radioactive power supply separated from the passenger cabin by a mile-long coaxial cable has been proposed.
- A household laundry detergent has been packaged in small plastic packets — one for each washer-load — that dissolve in the wash water.
- In a new air-tight plant filled with pure argon gas workers will wear "space" suits while fabricating at high temperatures such metals as molybdenum, tungsten and columbium.
- Copper reserves in the U. S. at the present time are estimated at 32,500,000 tons — enough to last 30 years at the present production rate.
- The British chemical industry has grown faster in the postwar years than any other British manufacturing activity.
- The major use of the lignite mined in the U. S. is for electric power generation and industrial steam raising.

Cheap Rockets for Daily Weather

A CHEAP PLASTIC rocket could be fired daily by Weather Bureau personnel in large cities, to provide more accurate weather forecasts. This is seen as a development following firings of the ARCAS rocket.

ARCAS stands for All Purpose Rocket for Collecting Atmospheric Findings. It is a solid fuel, low cost meteorological rocket that can be launched by a two-man crew.

Eventually the rocket will be made finely spun glass fibers so that it

may be fired over populated areas, then exploded into harmless fragments when the desired information has been gathered.

ARCAS test firings were conducted by the Army Signal Missile Support Agency at the White Sands Missile Range, N. Mex., for the Office of Naval Research. The rocket was made by the Atlantic Research Corporation here. It is seven feet long and four and a half inches in diameter. When fueled, it weighs 71 pounds.

Plastics Used in 3-D Art

TRANSLUCENT three-dimensional "paintings" are being designed from plastics styrene and polyethylene. Developed by William Lang, director of design, Monsanto Chemical Co., the forms are held in place in a frame

by thin, almost invisible, threads of nylon. Mr. Lang gets the colors, textures, and patterns he desires by "throwing things into the mixture — a dash of contrasting color, or something to create air bubbles or streaks."

Tires Made Radiation Proof

RADIATION-PROOF tires have been developed for use on future nuclear-powered aircraft. The tires are treated with anti-rads — chemical material added to rubber stocks before vulcanization to improve rubber's resistance to radiation damage.

Simulated landing tests have shown that irradiated tires protected with anti-rads rolled twice as many miles before failure than did irradiated tires without anti-rads, B. F. Goodrich Company Research Center reported in Brecksville, Ohio.

Chamber Aids Radiation Testing

A NEW irradiation chamber developed by the Hudson Bay Company promises to aid investigation of the effects of high temperature and nuclear radiation on test specimens. The shielded cabinets provide for environ-

mental tensile testing with a range of temperatures from minus 65 degrees to 350 degrees Fahrenheit. The door is concave so that all test specimens are an equal distance from the cobalt thus getting uniform radiation.

Book Condensations

DISCOVERING CHEMISTRY — Elizabeth K. Cooper — *Harcourt*, 190 p., illus. by author, \$3. Introduces boys and girls to the chemical elements, describes the structure of atom and molecule, illustrating with over 100 experiments safely performed in a home laboratory.

THE ROMANCE OF CHEMISTRY: From Ancient Alchemy to Nuclear Fission — Keith Gordon Irwin — *Viking*, 148 p., illus. by Anthony Ravielli, \$3.75. Story of the great chemists and their contributions, illustrated with very fine line-drawn portraits.

USING CHEMISTRY — Oscar E. Lanford — *McGraw*, rev. ed., 738 p., illus., \$5.48. Introductory chemistry course, emphasizing basic principles, with extensive section on organic chemistry brought up to date.

BRIEF COURSE IN ORGANIC CHEMISTRY — Lyell C. Behr, Reynold C. Fuson and Harold R. Snyder — *Wiley*, 2nd ed., 289 p., illus., \$5.75. Completely rewritten, more examples of reactions, more detailed explanations, questions at the ends of chapters added, while laboratory procedures have been omitted.

ROBERT BOYLE AND SEVENTEENTH-CENTURY CHEMISTRY — Marie Boas — *Cambridge Univ. Press*, 240 p., \$5.50. A study of Robert Boyle's influence on the development of chemistry.

THE EMERGENCE OF THE GERMAN DYE INDUSTRY — John Joseph Beer — *Univ. of Ill. Press*, 168 p., \$4.50, paper: \$3.50. Retells the story of the

growth of the organic dye industry, how and why it took root in Germany and transformed that nation's scientific research, chemical technology, education, business, international trade and laws.

SULFUR IN PROTEINS: Proceedings of Symposium held at Falmouth, Mass., May 1958 — Reinhold Benesko and others, Eds. — *Academic*, 469 p., illus., \$14. Deals with the role of sulfur in a variety of biological systems, presenting the findings of recent research.

ASPECTS OF THE ORGANIC CHEMISTRY OF SULPHUR — Frederick Challenger — *Academic*, 253 p., \$7.50. Of special interest to organic chemists, biochemists and those working in pharmaceutical and petroleum industry.

INDUSTRIAL FATTY ACIDS AND THEIR APPLICATIONS — E. Scott Pattison, Ed. — *Reinhold*, 230 p., illus., \$7.50. Covers the production and processing of fatty acids with emphasis on practical technology and the chemistry involved.

ULTRACENTRIFUGATION IN BIOCHEMISTRY — Howard K. Schachman — *Academic*, 272 p., illus., \$8.80. Theory and general description of the ultracentrifuge as a tool for the preparation and separation of proteins, viruses and other sedimentation experiments.

ENCYCLOPEDIA OF CHEMICAL REACTIONS, Vol. VIII: Tungsten, Uranium, Vanadium, Itrerbium, Yttrium, Zinc, Zirconium & Addenda — C. A. J.

on, Compiler, Clifford A. Hamp-
Ed. — *Reinhold*, 533 p., \$14. In
final volume, sequence system has
changed, entries are arranged in
alphabetical order of chemical sym-

QUALITATIVE ANALYSIS AND ANALY-
L CHEMICAL SEPARATIONS — Phil-
V. West and Maurice M. Vick —
millan, 2nd ed., 302 p., illus.,
0. Fundamental text for second
ester studies in general chemistry.
FUNDAMENTALS OF PHYSICAL CHEM-
Y — H. D. Crockford and Samuel
Knight — *Wiley*, 463 p., illus.,
5. Short course for biology and

premedical students, requiring only
limited background in mathematics.

SILICONES — R. N. Meals and F.
M. Lewis — *Reinhold*, 267 p., illus.,
\$5.95. On the manufacture, properties,
and applications of the silicones, with
data on the properties of silicone res-
ins, fluids, and rubbers at high temp-
eratures.

POLYMERS AND RESINS: Their
Chemistry and Chemical Engineering
— Brace Golding — *Van Nostrand*,
744 p., illus., \$15. Comprehensive vol-
ume covering the theory, chemistry,
properties, fabrication, and applica-
tion of commercial polymers and res-
ins.

On the Back Cover

CARL J. ALLEN, *Application Engi-*
at General Electric, demonstrates
new developments in the field of
astrial lighting. The lamp is 200
es smaller than present lamps of
ivalent power, and is self-cleaning
inside and out, resulting in high
iciency throughout its life.

These "Quartzline" lamps have a
ed tungsten filament within a $\frac{3}{8}$ "
meter quartz tube. Their rated life
000 hours, twice that of present
eties. They are able to maintain
of their initial light output
oughout their lives as a result of
unusual iodine cycle employed.

Previously incandescent lamps suf-
d from blackening on the inside,
sing loss in light output. This is
to tungsten deposits on the inside
ls of the lamps, the tungsten be-
vaporized from the filament. The
in "Quartzline" lamps contains a
ll amount of iodine which reacts
a the tungsten vapor. An iodide
ormed which condenses at too low

a temperature to deposit on the hot
outer wall. On diffusing back to the
filament, the compound decomposes,
the tungsten redeposits on the fila-
ment, and the iodine is free to recir-
culate. If the tungsten could be made
to deposit in the place from which it
originally came, the lamps would the-
oretically last forever. This however
cannot be achieved in practice, and
the filaments will thus grow thin and
eventually break at some point.

Because of their small size, the
"Quartzline" lamps lend themselves
to more precise optical control. The
back cover shows one of a series of
reflectors capable of throwing con-
centrated beams of light from the
square shape shown in the picture
down to a long narrow rectangle only
6 degrees wide, without the aid of
lenses.

Although too hot for domestic use,
"Quartzline" lamps should lead to
great improvements in flood-lighting
and industrial illumination.

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